TO EVALUATE AND COMPARE THE ANAESTHETIC EFFICACY OF INTRALIGAMENTARY, INTRAOSSEOUS TECHNIQUES AS THE PRIMARY ANAESTHETIC TECHNIQUE IN MAXILLARY FIRST AND SECOND MOLARS WITH LONG DISTOBUCCAL AND PALATAL ROOTS IN PATIENTS WITH ACUTE SYMPTOMATIC IRREVERSIBLE PULPITIS – *AN IN VIVO STUDY*

Dissertation submitted to

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BRANCH IV

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CHENNAI

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation titled **"To evaluate and compare the anaesthetic efficacy of intraligamentary, intraosseous techniques as the primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis – *An in vivo study*"** is a bonafide and genuine research work carried out by me under the guidance of **Dr. C S Karumaran M.D.S,** Professor , Department of Conservative Dentistry and Endodontics, Ragas Dental College and Hospital, Chennai.

Date : 11.02.2019

Place: Chennai

Dr. Darlene Ann Johnson
Post Graduate Student
Dept. of Conservative Dentistry & Endodontics
Ragas Dental College and Hospital
Chennai

CERTIFICATE

This is to certify that this dissertation titled **"TO EVALUATE AND COMPARE THE ANAESTHETIC EFFICACY OF INTRALIGAMENTARY, INTRAOSSEOUS TECHNIQUES AS THE PRIMARY ANAESTHETIC TECHNIQUE IN MAXILLARY FIRST AND SECOND MOLARS WITH LONG DISTOBUCCAL AND PALATAL ROOTS IN PATIENTS WITH ACUTE SYMPTOMATIC IRREVERSIBLE PULPITIS – *AN IN VIVO STUDY*"** is a bonafide record work done by **Dr. Darlene Ann Johnson**, under our guidance during her post graduate study period between **2016-2019**

This dissertation is submitted to **THE TAMILNADU Dr.M.G.R. MEDICAL UNIVERSITY**, in partial fulfillment for the degree of **MASTER OF DENTAL SURGERY – CONSERVATIVE DENTISTRY AND ENDODONTICS, BRANCH IV**. It has not been submitted (partial or full) for the award of any other degree or diploma.

Guided by:-

Dr.C.S. Karumaran,M.D.S.,
Professor
Department of Conservative
Dentistry & Endodontics,
Ragas Dental College & Hospital,
Chennai

Dr. C.S. KARUMARAN M.D.S.
DEPT. OF CONSERVATIVE DENTISTRY & ENDODONTICS
RAGAS DENTAL COLLEGE AND HOSPITAL
CHENNAI - 600 119.

Dr. R. Anil Kumar, M.D.S,
Professor and Head,
Department of Conservative,
Dentistry & Endodontics
Ragas Dental College & Hospital
Chennai

Dr.R.ANIL KUMAR.M.D.,
PROFESSOR AND HEAD
DEPARTMENT OF CONSERVATIVE
DENTISTRY & ENDODONTICS.
RAGAS DENTAL COLLEGE & HOSPITAL
CHENNAI

Dr. N.S.Azhagarasan, M.D.S
Principal,
Ragas Dental College & Hospital,Chennai

PRINCIPAL
RAGAS DENTAL COLLEGE AND HOSPITAL
UTHANDI, CHENNAI - 600 119.

THE TAMILNADU Dr. MGR MEDICAL UNIVERSITY
CHENNAI

PLAGIARISM CERTIFICATE

This is to certify that this dissertation work titled **"To evaluate and compare the anaesthetic efficacy of intraligamentary, intraosseous techniques as the primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis – *An in vivo study.* "** of the candidate **Dr. Darlene Ann Johnson** with Registration Number 241617152 for the award of **Master of Dental Surgery** in the branch of Conservative Dentistry and Endodontics. I personally verified the urkund.com website for the purpose of plagiarism Check. I found that the uploaded thesis file contains from introduction to conclusion pages and result shows **3%** of plagiarism in the dissertation.

DATE: 11.02.2019

PLACE: Chennai.

Dr. Darlene Ann Johnson
Post Graduate Student
Dept. of Conservative Dentistry & Endodontics
Ragas Dental College and Hospital
Chennai

Guide & Supervisor sign with seal.

Dr. C.S. Karumaran, M.D.S
Professor,
Department of Conservative Dentistry & Endodontics,
Ragas dental college and Hospital
Chennai

Dr. C.S. KARUMARAN M.D.S.
DEPT. OF CONSERVATIVE DENTISTRY & ENDODONTICS
RAGAS DENTAL COLLEGE AND HOSPITAL
CHENNAI - 600 119.

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LIST OF ABBREVIATIONS

SL.NO	**ABBREVIATIONS**	**DESCRIPTION**
1	LA	Local Anaesthesia
2	IOA/IO	Intraosseous Anaesthesia/Intraosseous Injection
3	ILA/ILI	Intraligamentary Anaesthesia/Intraligamentary Injection
4	PDL -I	Periodontal ligament Injection
5	BI	Buccal Infiltration
6	PSA	Posterior superior alveolar nerve block
7	IANB	Inferior Alveolar Nerve Block
8	CG	Control Group
9	ASIRP	Acute Symptomatic Irreversible Pulpitis
10	MRL	Mesiobuccal root length
11	DRL	Distobuccal root length
12	PRL	Palatal root length
13	HPVAS	Heft-Parker Visual Analog Scale

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Introduction

INTRODUCTION

Though pain garners outmost attention from all health care providers, most of the patients relates pain and dentistry to be synonymous. The predominant reason why most of the patients visit dental clinics is pain. The pain can be either pulpal or periodontal. As the etiology of the pain is multifactorial, diagnosing and managing them is crucial concern for patients and endodontists before, during and after endodontic procedure. Management of pain is achieved through local anaesthesia**.(Carlos Estrela 2011)**[7] Preanaesthetic agents, anaesthetic agents and techniques all play an important role in achieving good anaesthesia**.(Masoud Parirokh 2014, Parirokh M 2010, Modaresi J 2006, Ianiro SR 2007, Oleson M 2010)**[45 44 48 22 52]

It is easy to achieve good anaesthesia in healthy pulp than in inflamed pulp, as the perception of pain changes in each individuals **(Ehsan Moradi Askari 2016)**[12] Numerous investigations have been performed in the past to evaluate the efficacy of anaesthetic techniques in inflamed pulp. The inflamed pulp can be either acute symptomatic (reversible ,irreversible) pulpitis or chronic pulpitis. Among them, treating acute symptomatic irreversible pulpitis (ASIRP) is much more difficult. Local anaesthesia can be achieved by two ways either through primary anaesthetic techniques such as buccal infiltration (BI), buccal and palatal infiltration and posterior superior alveolar nerve block (PSA) **(Vivek Aggarwal 2011)**[75] or secondary anaesthetic techniques like Intraligamentary, (PDL,ILI) intraosseous (IO) intrapulpal, intraseptal, WAND,

C-CLAD system techniques have been administered in patients **(Quan Jing 2014)**[57]

Among the primary anaesthetic techniques, buccal infiltration (BI) anaesthesia is the most widely employed technique for maxillary molars and studies have shown its success rates to be 72% to 100% in healthy pulps **(Vivek Aggarwal 2011)**[75] However, studies shows that 12% -46% of maxillary molars with acute symptomatic irreversible pulpitis maybe only partially anaesthetised after buccal infiltration with 2% lidocaine **(Ehsan Moradi Askari 2016)**[12]

Vivek Aggarwal et al 2011[75] and **Anna Guglielmo et al 2011**[2] in their studies concluded that the anaesthetic efficacy of 2% lidocaine with either 1:200,000 and 1:80,000 epinephrine in inflamed pulp was 54% for (buccal infiltration BI), 74% for (buccal and palatal infiltration) and 64% (PSA) respectively. None of the tested methods gave 100% anaesthetic success rates in maxillary molars with acute symptomatic irreversible pulpitis **(Vivek Aggarwal 2011)**[75]

The secondary mode of achieving pulpal anaesthesia is through Intraosseous anaesthesia (IOA). This technique was first introduced by **Lilienthal et al in (1975) . (J G Meechan 2002**)[25] This technique involves deposition of the anaesthetic solution directly into the cancellous bone with the help of special needles **(Juliane Gallatin 2003)**[32]

Intraligamentary injection technique otherwise known as(peridental or Periodontal ligament injection) was introduced by **Cassamani et al in 1924**.. It delivers local anaesthesia solution via the gingival sulcus to the periodontal tissue to provide reversible nerve block. This technique reported to have high success rate when used either as a primary or secondary mode of anaesthetic technique which was highlighted by various authors[29, 38, 41, 45, 46, 66, 76]

Another variable which influenced the success of local anaesthesia in clinical situation which was not explored extensively is the length of the roots **(Ingle J, Kim E)**[80,37] **Hamid Reza Hosseini**[18] in **2016** investigated the effect of increased root length and different anaesthetic agents in the success rate of local anaesthesia. He concluded that increased length of palatal root adversely affects the success of anaesthesia irrespective of the agent used.The success rate in his study was 56.52%. In the same year **2016 Ehsan Moradi Askari**[12] also conducted a study stressing on the effect of maxillary molar root length on the success rate and reported an overall 61% in success rate. Till now there are only two studies which correlates the root length and its local anaesthetic success rate. A pubmed index search was conducted with the key words as intraosseous technique, intraligamentary technique, long distobuccal and palatal roots. The total number of articles on intraligamentary injection is **168**, intraosseous injection **404** and for long distobuccal root **2**[12 37] and for long palatal roots it was **3**[12 18 37]

With this as the background, this study was designed to evaluate and compare the anaesthetic efficacy of intraligamentary, intraosseous techniques when used as a primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis (ASIRP)

AIM:

The aim of this *in vivo* study is to determine the anaesthetic efficacy of intraligamentary, intraosseous techniques when used as primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis

OBJECTIVE:

- This study is designed to evaluate and compare the anaesthetic efficacy of intraligamentary, intraosseous techniques with conventional buccal and palatal infiltration technique – (2% lignocaine with 1:80,000 epinephrine) in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis – A clinical trial.

- To evaluate the pain present during dentin cutting, pulp exposure and instrumentation of root canals during the endodontic procedure.

Aim and Objectives

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Review of Literature

REVIEW OF LITERATURE

Richard E Walton et al (1982)[62] in his study determined whether the periodontal tissues were damaged by the periodontal ligament injection histologically. He used a 30 gauge needle and wedged it into the crestal periodontal ligament space, and the solutions were injected under maximum pressure. The injected areas were examined at 0,10 and 25 days. He concluded that there was minor distruption at the crestal area with minimal damage to the periodontium.

G Norman Smith et al (1983)[16] simulated a clinical technique using radiopaque solution and colloidal carbon suspension injecting into the periodontal ligament of dogs using a standard syringe. He concluded that the colloidal method was superior when compared to the radiopaque solution because the injecting material was found in soft tissue and adjacent hard structures and in vessels of the pulps of the immediate and adjacent teeth.

D Galili et al (1984)[8] conducted a study that evaluated histologically any damage to the periodontal ligament apparatus in baboon monkeys. He concluded that the damage induced by the injection needle/anaesthetic solution which was injected under pressure was localized, minor and reversible in nature. In most of the specimen, all signs of damage disappeared within 8 days after injection.

Raymond D Rawson et al (1985)[60] demonstrated the vascular penetration following intraligamentary injection using an intraligamentary injection syringe and the spread of solution was radiograhically examined. He concluded that routine use of intraligamental injections for reinforcement of conventional anaesthesia should be carefully evaluated because of lack of fine control and high potential for intravascular injection.

H Rakusin et al (1986)[20] conducted a clinical study on lower first molar teeth on both sides of the mouth of the same patient. Periodontal ligament injection was administered to the test tooth and inferior alveolar nerve block to the control tooth. He concluded that periodontal ligament injection produced no measured changes in either the tooth or periodontium.

Joesph E D'Souza et al (1987)[31] evaluated the effects of periodontal ligament injection its extent of anaesthesia and post injection discomfort. Results of the study indicated that no statistical difference in anaesthesia achieved from pistol-pressure or standard-grip syringe was observed.

James O Roahen et al (1990)[23] in his study investigated histologically the effects of periodontal ligament injection on the pulp of teeth with or without subsequent amalgam restorations, and the effects of the injection on the periodontium. He concluded that this technique does not have long term deleterious effects on the pulp, but can induce localized external root resorption.

Toni L Eigner et al (1990)[74] employed intraligamentary anaesthesia in patient with severe hemophilia and factor VIII inhibitor. Intraligamentary anaesthesia was used during the restorative procedures that was performed throughout an 8-year period on a patient with factor VIII inhibitor. He concluded that periodontal ligament injection of fentanyl as a supplemental technique to the standard local infiltration anaesthesia is effective and reliable technique.

Michael Childers et al (1996)[46] conducted a study to determine the anaesthetic efficacy of the periodontal ligament injection after an inferior alveolar nerve block. 40 patients randomly received a combination of IAN block and PDL injections of the first mandibular molar using 2% lidocaine with 1:100,000 epinephrine and a combination of IAN block and mock PDL injections at two successive appointments. Combination of IAN/PDL injections showed higher incidence of successful pulpal anaesthesia through the first 23 mins of pulpal testing. He concluded that adding PDL injection to an IAN block increased the incidence of pulpal anaesthesia for the first 23 mins in the first molar.

Randall Coggins et al (1996)[59] evaluated the anaesthetic efficacy of intraosseous injection as the primary technique in human maxillary and mandibular teeth. 40 subjects received two sets of intraosseous injections with 1.8 ml of 2% with 1:100,000 epinephrine at two successive appointments.

Anaesthetic success was seen in 75% of mandibular first molars, 93% of maxillary first molars, 78% of mandibular lateral incisors and 90% of maxillary lateral incisors. Overall IO injection onset was immediate, the pulpal anaesthesia steadily declined over the 60 mins. He concluded that IO injection may provide pulpal anaesthesia in 75% to 93% of non inflamed teeth when used as a primary injection technique.

Deron Reisman et al (1997)[11] evaluated the anaesthetic efficacy of a supplemental intraosseous injection of 3% mepivacaine in mandibular posterior teeth with irreversible pulpitis. 48% with irreversible pulpitis received conventional IAN block. Electric pulp testing was used to determine pulpal anaesthesia. During the endodontic procedure, patients received IO injection of 1.8 ml of 3% mepivacaine. A second IO injection of 3% mepivacaine (1.8 ml) was administered if the first injection was unsuccessful. He concluded that supplemental IO injection of 3% mepivacaine increased anaesthetic efficacy rate. Additional second IO injection further increased the success rate.

John Nusstein et al (1998)[30] determined the anaesthetic efficacy of a supplemental IO injection of 2% lidocaine with 1:100,000 epinephrine in teeth with irreversible pulpitis. Results demonstrated that 42% of patients who tested negative to the pulp tests reported pain during treatment and required supplemental anaesthesia. 81% of mandibular teeth and 12% of maxillary

teeth required an IO injection. He concluded that for posterior teeth with irreversible pulpitis, the IO supplemental injection technique of 2% lidocaine with 1:100,000 epinephrine was successful over conventional anaesthetic technique.

Stephen A Parente et al (1998)[70] evaluated the anaesthetic efficacy of supplemental IOI of 2% lidocaine with 1:100,000 epinephrine using the stabident device after conventional anaesthetic mode fails. 37 patients diagnosed with irreversible pulpitis were selected for this study. Patients with maxillary teeth received infiltration anaesthesia, and those with mandibular teeth received IAN block along with long buccal infiltration. Stabident IOI was effective supplemental anaesthetic technique in 89%. Mandibular teeth showed success rate of 91% with IOI and 67% in maxillary teeth.

Juliane Gallatin et al (2003)[32] compared two IO anaesthetic techniques in mandibular posterior teeth (Stabident and X-tip system) anaesthetic success rates for stabident technique and the X –tip technique were respectively 93% for mandibular first molar and 95% for mandibular second molar and 83% second premolar with no significant differences between the two techniques. He concluded that the two primary IOI techniques were similar regarding anaesthetic success, onset, duration.

Hristina Lalabonova et al (2005)[21] evaluated the use of intraligamentary anaesthesia in general dental practice. Results showed that out of 220 general dental practitioners interviewed in this study. The results showed that 75.91% of the dental practitioners used intraligamentary injection technique in almost all types of dental treatment. Complications were found in 27.54%. The anaesthesia was sufficiently effective in only 32.94%.

Narasimhan Srinivasan et al (2008)[51] conducted a prospective, randomized, double-blind study to compare the anesthetic efficacy of 4% articaine and 2% lidocaine with 1:100,000 for buccal infiltration in patients with irreversible pulpitis in maxillary posterior teeth.40 patients were divided into 4 groups respectively. The success rate for maxillary buccal infiltration to produce pulpal anaesthesia using 4% articaine was 100% in first premolar and first molar, for lidocaine solution the success rate was only 80% for first premolar and 30% for first molar. He concluded that the efficacy of 4% articaine was superior to 2% lidocaine for maxillary buccal infiltration in posterior teeth.

Michael G Sherman et al (2008)[47] conducted a randomized, double-blind study to compare the anaesthetic efficacy of 4% articaine with 1:100,000 epinephrine with 2% lidocaine with 1:100,000 epinephrine for Gow- Gates block and maxillary infiltration in patients diagnosed with irreversible pulpitis. Overall anaesthetic success rate for both dental arches

was 87.5%. 4% articaine with 1:100,000 epinephrine was considered superior to 2% lidocaine.

Grace Evans et al (2008)[17] evaluated the anaesthetic efficacy of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine in maxillary lateral incisors and first molars. Maxillary lateral incisors exhibited higher success rate of 88% anaesthesia with 4% articaine and 62% success rate with lidocaine. She concluded that maxillary infiltration of 4% articaine with 1:100,000 epinephrine statistically improved anaesthetic success when compared with 2% lidocaine with 1:100,000 epinephrine in lateral incisor but not in first molars.

Song Fan et al (2009)[68] compared the anaesthetic efficacy of IANB plus buccal infiltration and IANB plus periodontal ligament articaine injection in patients with irreversible pulpitis in mandibular first molar.57 patients were included in this study which was divided into 2 groups. Anaesthetic success occurred in 81.48% for IANB plus buccal infiltration compared with 83.33% for IANB plus PDL injection.

Rick Mason et al (2009)[63] evaluated the anaesthetic efficacy of 2% lidocaine with 1:100,000 epinephrine and 1:50,000 epinephrine and 3% mepivacaine in maxillary lateral incisors and first molars. 60 patients were selected for this double-blind crossover study. Anaesthetic success and the onset of pulpal anaesthesia were not significantly different between 2%

lidocaine with either 1:100,000 or 1:50,000 epinephrine and 3% mepivacaine for lateral incisor and first molar. Increasing the epinephrine concentration decreased the pulpal for a short duration for lateral incisor but not for first molar. 3% mepivacaine significantly increased the pulpal anaesthesia for both lateral incisor and first molar when compared to 2% lidocaine.

Masoud Parirokh et al (2010)[44] assessed the anaesthetic efficacy of IANB combined with buccal infiltration in mandibular molar with irreversible pulpitis. 84 patients were selected for this study which was divided into 3 groups respectively. Lidocaine 2% with 1:80,000 epinephrine was administered for all patients. Group 1 – (IANB 1.8 ml) Group 2 –(IANB 3.6 ml) and Group 3- (IANB 1.8 ml + 1.8 ml buccal infiltration). The success rate for groups I to III were 14.8%, 39.3% and 65.4% . He concluded that combining IANB along with buccal infiltration injection provided profound anaesthesia in mandibular molars with irreversible pulpitis.

Suttapreyasri Srisurang et al (2010)[72] compared the anaesthetic efficacy of single buccal and palatal infiltration of 2% lidocaine, 2% mepivacaine or 4% articaine with 1:100,000 epinephrine by maxillary anaesthetic technique. The extent of anaesthetization produced by 4% articaine was statistically more significant than 2% lidocaine and 2% mepivacaine. The successful anesthetization of adjacent teeth occurred more in the articaine group than lidocaine and mepivacaine groups. He concluded

that local anesthetization using 4% articaine with 1:100,000 epinephrine covers wider area soft tissue and adjacent teeth than 2% lidocaine or 2% mepivacaine.

Steven Katz et al (2010)[71] evaluated the anesthetic efficacy of 2% lidocaine with 1:100,000 epinephrine, 4% prilocaine with 1:200,000 epinephrine and 4% prilocaine in maxillary lateral incisors and first molars. For both lateral incisors and first molar, 4% prilocaine with 1:200,000 epinephrine and 2% lidocaine with 1:100,000 epinephrine were equivalent for incidence of pulpal anesthesia. He concluded that 4% prilocaine provided a significantly shorter duration of pulpal anesthesia compared with 2% lidocaine with 1:100,000 epinephrine and 4% prilocaine with 1:200,000 epinephrine.

Carlos Estrela et al (2011)[7] conducted a retrospective survey which was designed to identify subgroups and clinical factors associated with odontogenic pain and discomfort in dental urgency patients. He concluded that the most common endodontic diagnosis of pulpal pain was symptomatic pulpitis (28.3%), hyperreactive pulpalgia (14.4%) and the most frequent periapical pain was symptomatic apical periodontitis (26.4%). Regression analysis revealed that closed pulp chamber and caries are highly associated with pulpal pain and open pulp chamber is associated with periapical pain.

Sreekumar K et al (2011)[34] compared the onset and duration of action of soft tissue and pulpal anesthesia with three volumes of 4% articaine with 1:100,000 epinephrine in maxillary infiltration anesthesia. The 1.2 ml dose induced faster onset of pulpal anesthesia, a higher success rate, and a longer duration of soft tissue/ pulpal anesthesia than 0.6 ml. Group 3 had longer soft tissue anesthesia as compared to Group 1 and 2. He concluded that maxillary infiltration anesthesia with articaine and epinephrine has a faster onset, greater success rate and longer duration when a volume 1.2 ml is used than 1.0 ml are used.

Anna Guglielmo et al (2011)[2] compared and evaluated the anesthetic efficacy of a combination palatal and buccal infiltration of the maxillary first molar. 40 subjects received two sets of maxillary first molar infiltration at two separate appointments spaced at least 1 week. The anesthetic used in this study was 2% lidocaine with 1:100,000 epinephrine. One set of infiltration consisted of a buccal infiltration of 1.8 ml of anesthetic and palatal infiltration of 0.5 ml of anesthetic. The other set consisted of a buccal infiltration of 1.8 ml of anesthetic and a mock palatal infiltration. The success rates were 88% for the buccal infiltration and 95% for the buccal and palatal infiltration. The buccal and palatal infiltration significantly increased the incidence of pulpal anesthesia from 21 min to 57 mins.

Paul A Moore et al (2011)[54] compared and evaluated the periodontal ligament and intraosseous anesthetic injection techniques in mandibular molars and concluded that periodontal ligament injection and IOI are effective anesthetic techniques in managing nerve block failures and for providing localized anesthesia in the mandible.

Vivek Aggarwal et al (2011)[75] compared and evaluated the anesthetic efficacy of posterior superior alveolar (PSA) nerve blocks, buccal infiltrations, and buccal plus palatal infiltrations with 2% lidocaine with 1:200,000 epinephrine in maxillary first molars with irreversible pulpitis. 94 patients participated in this randomized, single-blinded study which was divided into 3 groups respectively. 28 patients received PSA block, 33 patients received buccal infiltration and 33 patients received buccal plus palatal infiltration with 2% lidocaine with 1:200,000 epinephrine. He concluded that none of the tested methods gave 100% anesthetic success rates PSA (64%), buccal infiltration (54%) and buccal and palatal infiltration (70%) in maxillary first molars with irreversible pulpitis.

Majidah K W et al (2012)[41] compared and evaluated the anesthetic efficacy of the periodontal ligament injection using 2% lidocaine with 1:80,000 epinephrine and normal saline in maxillary and mandibular posterior teeth. 40 patients participated in this study and were divided into 4 group respectively. Results showed that the duration of profound pulpal

anesthesia, using 2% lidocaine with 1:80,000 epinephrine was 10 minutes and injection of anesthestic solution and normal saline in clinically healthy teeth were only mildly discomforting. He concluded that periodontal ligament injection can be used effectively as a primary injection technique to anesthetize mandibular posterior teeth.

Mohammad D Kanaa et al (2012)[49] assessed the efficacy of buccal infiltration of 4% articaine with 1:100,000 epinephrine and 2% lidocaine with 1:80,000 epinephrine in maxillary teeth with irreversible pulpitis. 100 patients diagnosed with irreversible pulpitis were selected in this randomized double-blind clinical study. Patients received 2.0 ml 4% articaine with 1:100,000 epinephrine or 2% lidocaine with 1:80, 000 epinephrine in the buccal sulcus adjacent to the tooth with pulpitis. 50 patients received articaine and 50 patients received lidocaine. 73 of 100 patients achieved pulpal anesthesia within 10 minutes of injection, 38 of 100 after articaine and 35 of 100 after lidocaine. Pain free treatment was completed in 33 patients after articaine and 29 patients after lidocaine buccal infiltration injection.

Davood Ghasemi Tudeshchoie et al (2013)[10] compared and evaluated the anesthetic efficacy of two anesthetic techniques of mandibular first molar. 40 participants were selected for this randomized clinical trial study and each patients were divided into two groups respectively. The right and left mandibular first molars of group A were anesthetized with infiltration

and inferior alveolar nerve block techniques in the first and second sessions. The left and right mandibular first molars of group B were anesthetized with inferior alveolar nerve block and infiltration techniques in the first and second sessions respectively. The severity of pain were measured and recorded accordingly. The severity of pain was lower in infiltration technique versus inferior alveolar nerve block. He concluded that infiltration technique was more favourable to anesthetize the mandibular primary first molar when compared to inferior alveolar nerve block.

Masoud Parirokh et al (2014)[45] compared and evaluated the anesthetic efficacy of inferior alveolar nerve block injection technique for mandibular first molar teeth with irreversible pulpitis with or without supplemental buccal infiltration and intraligamentary injection. 82 patients were selected in this randomized double-blind controlled trial having asymptomatic irreversible pulpitis. Patients received either a combination of intraligamentary injection+buccal infiltration + IANB or with traditional IANB injection in mandibular first molar teeth with irreversible pulpitis. The success rate of anesthesia in the IANB and the combination group were 22% and 58% respectively. He concluded that combination anesthetic technique improved the success rate of anesthesia for mandibular first molar teeth with irreversible pulpitis.

K Peycheva et al (2014)[38] compared the efficacy of intraligamentary anesthesia of mandibular molars for endodontic treatment. A total of 130 patients were selected for this study. Out of 300 patients, 125 cases the technique was successful. Failure of anesthesia was seen in 5 cases. He concluded that intraligamentary injection technique can be employed as a primary anesthetic technique for endodontic treatment.

Brett Nydegger et al (2014)[6] compared the pulpal anesthesia obtained using 4% concentration of prilocaine, lidocaine, and articaine formulations as the primary buccal infiltrations of the mandibular first molar. 60 asymptomatic subjects randomly received a primary mandibular buccal first molar infiltration of 1.8 ml 4% articaine with 1:100,000 epinephrine and 4% lidocaine with 1:100,000 epinephrine and 4% prilocaine with 1:200,000 epinephrine in 3 separate appointments. The success rate for 4% articaine formulation was 55%, 33% for 4% lidocaine formulation and 32% for 4% prilocaine formulation. 4% articaine formulation was considered to be superior than both 4% lidocaine and 4% prilocaine formulations for buccal infiltration of mandibular first molars.

Brandon S Rogers et al (2014)[5] compared the anesthetic efficacy of 4% articaine with 2% lidocaine for supplemental buccal infiltrations after an ineffective IANB in mandibular molar with irreversible pulpitis. 100 subjects were selected in this randomized, double-blind study diagnosed with

irreversible pulpitis. 1.7 ml of anesthetic solution with 1:100,000 epinephrine was administered. Patients ineffective to IANB was given additional 4% articaine or 2% lidocaine as supplemental buccal infiltration. 74% patients failed to achieve pulpal anesthesia after IANB with 4% articaine and 37% for lidocaine. This was more profound in the second molar. He concluded that supplemental buccal infiltration with articaine was significantly more higher than lidocaine.

Quan Jing et al (2014)[57] evaluated the effectiveness and safety of a computer –controlled periodontal injection system to the local soft tissues as the primary technique in endodontic access to mandibular posterior teeth in patients with irreversible pulpitis. All patients received computer-controlled PDL injection of 4% articaine with 1:100,000 epinephrine. Overall success rates were 76.5%. There was no significant difference in success rates among premolars, maxillary first molar and maxillary second molar(92.1%, 53%, 93.1%). He concluded that computer-controlled PDL injection system demonstrated both satisfactory anesthetic effects and safety in local soft tissue as primary anesthetic technique.

Kaitlyn Tom et al (2015)[35] conducted a literature review to determine IO anesthesia as a primary anesthesia in dentistry. He concluded that computer-controlled IO anesthesia is an effective primary technique for limited procedures involving one or two posterior teeth in the mandible.

Compared to traditional local anesthetic techniques, IO (1.5-1.8 ml of 4% articaine with 1:100,000 epinephrine for adults and 0.6 -0.8 ml of 4% articaine with 1:200,000 epinephrine for children) offers high success rates, ease of administration, fast onset and better patient compliance.

Ryan Shurtz et al (2015)[64] compared the degree of pulpal anesthesia obtained with a buffered 4% articaine with 1:100,000 epinephrine formulation versus a nonbuffered 4% articaine with 1:100,000 epinephrine formulation as a primary buccal infiltration of mandibular first molar. Subjects randomly received buccal infiltration using 4% articaine with 1:100,000 buffered with 8.4 ml sodium bicarbonate (18mEq) and 4% articaine with 1:100,000 epinephrine in a double-blind manner at two separate appointments. Anesthetic success rates for buffered articaine and non buffered articaine were 71% and 65% respectively. No significant differences were found between the 2 formulations for pain of injection or onset of anesthesia. He concluded that buffered articaine did not provide any advantage over nonbuffered articaine for anesthetic success, anesthesia onset,or pain of injection for primary buccal infiltration of mandibular first molar.

Masoud Parirokh et al (2015)[43] compared and evaluated the success rate of two anesthetic agents (bupivacaine and lidocaine) for IANB for treating patients with irreversible pulpitis. Patients were randomly divided and administered either 2% lidocaine with 1:80,000 epinephrine or 0.5%

bupivacaine with 1:200,000 epinephrine as an IANB injection. The success rate for bupivacaine and lidocaine were 20.0% and 24.1% respectively. There was no significant difference between the two groups at any stage of the treatment procedure. He concluded that there was no significant difference in the success rates of anesthesia when bupivacaine and lidocaine were used for IANB injections to treat mandibular molar teeth with irreversible pulpitis.

Hamid Reza Hosseini et al (2016)[18] compared and evaluated the efficacy of 2% lidocaine to 4% articaine in buccal infiltration of maxillary first molars with irreversible pulpitis. Fifty patients having painful maxillary first molars with irreversible pulpitis recieved an infiltration either 4% articaine with 1:100,000 epinephrine or 2% lidocaine with 1:80,000 epinephrine. Anesthetic success rates for lidocaine and articaine were 56.52% and 66.67% respectively. Irrespective of the anesthetic agent used, the length of palatal root had an adverse effect on anesthetic success. He concluded that no significant difference was found between 2% lidocaine and 4% articaine in terms of anesthetic success in maxillary molar teeth with irreversible pulpitis.

Shaul Lin et al (2016)[66] evaluated the success rate of intraligamentary injection using two-or four-site injection technique.150 cases were selected in this study diagnosed with asymptomatic irreversible pulpitis received ILI at the mesiobuccal and distobuccal aspects of the roots.IL anesthesia was considered successful in 92.1% of the case. Forty eight teeth

(31.8%) were sufficiently anesthetized using the two-site ILI and 91 teeth (60.3%) following IL anesthesia in two more sites. He concluded that using four-site IL injections as a primary anesthetic technique may be considered an alternative to common IANB.

Vivek Aggarwal et al (2017)[76] compared and evaluated the efficacy of 0.2 ml vs 0.6 ml of 2% lidocaine with 1:80,000 epinephrine when given as a supplemental intraligamentary injection after a failed IANB. ILI with 0.2 ml solution gave an anesthetic success rate 64%, while the 0.6 ml was successful in 84% of the cases with failed primary IANB. He concluded that increasing the volume of intraligamentary injection improved the success rates after a failed primary anesthetic injection.

Materials and Methods

MATERIALS AND METHODS

Armamentarium:

- Stabident system (Fairfax Dental Inc., Miami, FL,USA.).
- 1.8ml catridges of 2% Lignocaine with 1:80,000 epinephrine.(Lignospan special, Septodont).
- 2% Lignocaine with 1:80,000 adrenaline.
- Metalsyringe, breech type catridge loading, aspirating syringe. (Petite Aspirating dental injection syringe).
- 27 gauze short needle.(septoject).
- UNOLOK –single use 2 ml syringe (Hindustan syringes and medical devices LTD)
- Topical anesthetic gel Benzocaine 20% (xylocaine jelly, Septodont ,India).
- Contra-angle handpiece.(NSK contra angle for latch burs)
- Electric Pulp Tester **Digitest** II_{TM}
- Apex Locator (Morita ROOT ZX mini)
- X-SMART™ (DENSPLY MAILLEFER)

INCLUSION CRITERIA

- Patients diagnosed with acute symptomatic irreversible pulpitis.
- No history of oral antibiotics or pain killers taken before the procedure.
- Adult volunteers aged between 19 -45 years
- Absence of periapical radiolucency except for periapical widening.
- Vital coronal pulp on access opening.
- Ability of the patients to understand the use of pain scales.

EXCLUSION CRITERIA

- Younger than 18 years and older than 65 years of age.
- Allergies to local anaesthesia or sulfites
- Pregnant females and lactating mothers.
- Patients with active sites of pathosis in area of injection.
- Patients with history of significant medical conditions (American Society of Anaesthesiologists II or higher).
- Patients on any medications (over –the – counter pain reliveing medications, narcotics, sedatives, antianxiety, or antidepressant medications)

GROUPS

- **GROUP A** : Buccal and palatal infiltration with 2% lidocaine in 1:80,000 epinephrine.
- **GROUP B** : Intraligamentary injection with 2% lidocaine in 1:80,000 epinephrine.
- **GROUP C:** Intraosseous injection with 2% lidocaine in 1:80,000 epinephrine.

METHODOLOGY

Sixty adult volunteer patients participated in this single- blinded study. All endodontic treatment was performed in the department of Conservative Dentistry and Endodontics by the operator from October 2017 – October 2018. Ethical clearance was provided by the Institutional review committee of Ragas dental college and hospital- Chennai, and informed written consent was obtained from each patient.

Pre operative radiographs were taken. Pulp sensibility tests was determined before and after the administration of the local anaesthesia. The patients were in good health and none of them were taking any medications that altered their pain perception. All patients signed an informed consent form either in English or in their native language. The primary investigator examined and selected the patients for the study.

The patients were explained the pain scales and the procedures. The subjects were asked to rate their pre treatment pain on a 170 mm Heft-Parker Visual analog scale (HPVAS) . The scale was divided into four categories: "**no pain"** corresponds to 0 mm; " **mild pain**" was defined as being >0 mm ≤54 mm; "**moderate pain**" was defined as being >54 mm <114 mm; and "**severe pain**" was defined as being ≥114 mm[12].

All sixty patients were divided into three study groups. **In Group A**, 20 patients were administered with buccal and palatal infiltration (2% lidocaine with 1:80,000 epinephrine) in maxillary first/second molars. After applying topical anaesthesia (20 % benzocaine) to the site of the injection, the needle was penetrated (27- G 25 mm) between the mesiobuccal and distobuccal root apices of the maxillary first/second molars into the alveolar mucosa. The amount of needle penetration was estimated by the initial radiograph that was taken with the parallel technique so that the injection was given above the root apices of the buccal roots of the teeth. After needle penetration toward the target site, aspiration was performed in 2 different planes. 1.4 ml of anesthetic solution was deposited at the rate of 1 mL/min. After 2 minutes of buccal infiltration, a palatal infiltration was given. The injection site was centered halfway between the mid-palatine raphae and the gingival margin of the teeth. The infiltration injection used standard aspirating syringe; a new 27- G, 1 –inch needle; and 2% lidocaine with 1:80,000 epinephrine. The needle was gently placed into the palatal mucosa with the

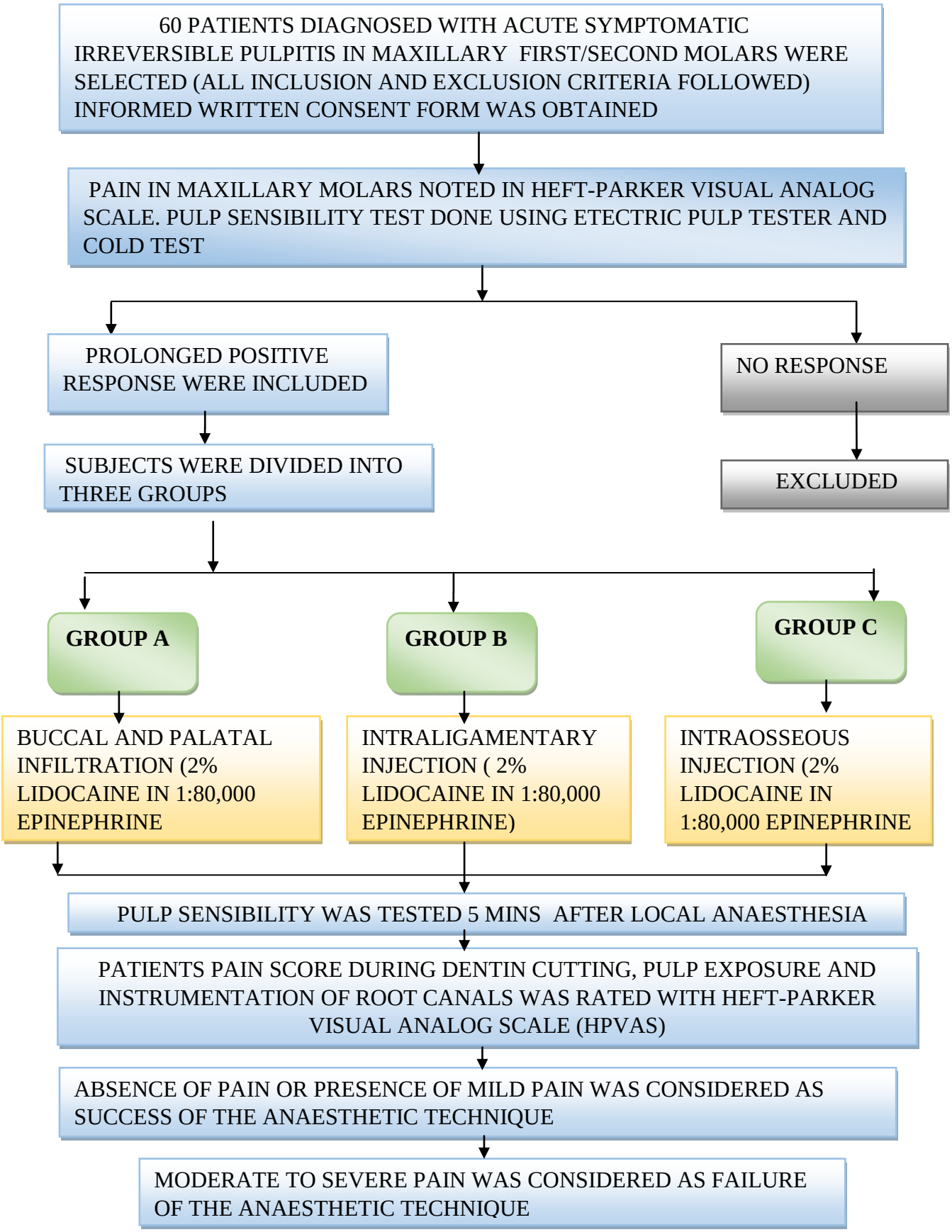
bevel towards the bone and advanced until bone was gently contacted. After aspiration, 0.4 ml of 2% lidocaine with 1:80,000 adrenaline was deposited over 30 seconds[2 12]

In Group B, 20 patients were administered with intraligamentary injection (2% lidocaine with 1:80,000 epinephrine) using the pressure type syringe and 27 gauge needles. The needle was slightly bent in the centre for easy placement. The needle was inserted in the mesial gingival sulcus at the mesio-buccal line angle of the tooth. The needle was firmly inserted between the alveolar bone and the tooth until resistance was felt. The needle was placed at an angle of 30˚ from the long axis of the tooth. The handle/ trigger was firmly squeezed to complete one squeeze (which deposited 0.2 ml) under strong back pressure. If no back pressure was felt, then the needle was re-positioned and the injection was repeated until back pressure was achieved. A total of 0.6 ml of anaesthetic solution (three squeezes of the pressure syringe) was injected. The needle and pressure was maintained in place for another 20 seconds after injection. The same procedure was repeated for the distal root. The site of distal injection was the gingival sulcus at the disto- buccal line angle. For the 0.2 ml group, same procedure was used to give injections. After depositing 0.2 ml injection, the needle was gently loosened and was taken out from the gingival sulcus[76].

In Group C, 20 patients were administered with intraosseous Injection through Stabident device (2% lidocaine with 1:80,000 epinephrine).

Infiltration of 0.2 ml of local anaesthetic in the attached gingival at a site distal to the tooth requiring treatment was given. The perforator was attached to the contra-angle of a slow-speed handpiece was used to produce a pilot hole. The perforator tip was placed on the gingival tissue or mucosa perpendicular to a point 2 mm apical to the intersection of an imaginary horizontal line along the gingival margins with a vertical line through the interdental papilla. A few sharp bursts of low rpm operation with light pressure was applied until the sensation that the perforator had penetrated the cortical plate into the cancellous bone occurred. The Stabident injector tip attached to a standard dental aspirating syringe was used to slowly inject 0.45 to 0.9 ml of 2% lidocaine with 1:80,000 epinephrine. If resistance to the injection of the anaesthetic solution was encountered, the syringe was rotated slightly or an alternative injection site was prepared[70]

Successful pulpal anesthesia was defined as no pain or weak/mild pain during dentin cutting, pulp exposure and instrumentation of root canals. The subjects were instructed to rate their pain in the Heft – Parker Visual Analog Scale (HPVAS**)**.The findings were recorded on Microsoft Excel sheet (Microsoft office Excel 2010 for statistical evaluation using the program SPSS version 20.0. Age, sex, and pain during dentin cutting, pulp exposure and instrumentation of root canals were summarized by evaluating the tables and descriptive statistics. The statistical tests used were chi-square and One way ANOVA.


60 PATIENTS DIAGNOSED WITH ACUTE SYMPTOMATIC IRREVERSIBLE PULPITIS IN MAXILLARY FIRST/SECOND MOLARS WERE SELECTED (ALL INCLUSION AND EXCLUSION CRITERIA FOLLOWED) INFORMED WRITTEN CONSENT FORM WAS OBTAINED
PAIN IN MAXILLARY MOLARS NOTED IN HEFT-PARKER VISUAL ANALOG SCALE. PULP SENSIBILITY TEST DONE USING ETECTRIC PULP TESTER AND COLD TEST
PROLONGED POSITIVE RESPONSE WERE INCLUDED
NO RESPONSE
SUBJECTS WERE DIVIDED INTO THREE GROUPS
EXCLUDED
GROUP A
GROUP B
GROUP C
BUCCAL AND PALATAL INFILTRATION (2% LIDOCAINE IN 1:80,000 EPINEPHRINE
INTRALIGAMENTARY INJECTION (2% LIDOCAINE IN 1:80,000 EPINEPHRINE)
INTRAOSSEOUS INJECTION (2% LIDOCAINE IN 1:80,000 EPINEPHRINE
PULP SENSIBILITY WAS TESTED 5 MINS AFTER LOCAL ANAESTHESIA
PATIENTS PAIN SCORE DURING DENTIN CUTTING, PULP EXPOSURE AND INSTRUMENTATION OF ROOT CANALS WAS RATED WITH HEFT-PARKER VISUAL ANALOG SCALE (HPVAS)
ABSENCE OF PAIN OR PRESENCE OF MILD PAIN WAS CONSIDERED AS SUCCESS OF THE ANAESTHETIC TECHNIQUE
MODERATE TO SEVERE PAIN WAS CONSIDERED AS FAILURE OF THE ANAESTHETIC TECHNIQUE

Figures

FIG 1: NSK CONTRA ANGLE HANDPIECE

FIG 2: 2% LIGNOCAINE WITH EPINEPHRINE INJECTION 1P

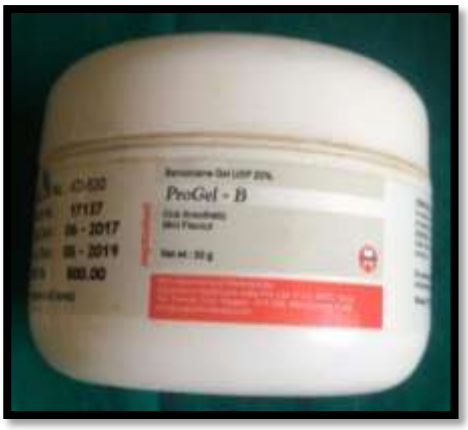


FIG 3: 20% BENZOCAINE GEL USP

FIG 4: 2.5ML SINGLE USE LEUER LOCK SYRINGE (UNOLOK)

FIG 5: 27-GAUGE STERILE, SILICONISED DISPOSABLE NEEDLE SEPTOJECT

FIG 6: 27- GAUGE STABIDENT NEEDLE

FIG 7: METAL BREECH TYPE, CATRIDGE LOADING ASPIRATING SYRINGE

FIG 8: 1.8 ML OF 2% LIDOCAINE WITH 1:80,000 EPINEPHRINE CATRIDGES

FIG 9: DIGITEST II ELECTRIC PULP TESTER

FIG 10: THE ARMAMENTARIUM

FIG 11: APPLICATION OF THE TOPICAL ANAESTHETIC GEL

FIG 12: PULP TESTING USING THE ELECTRIC PULP TESTER

FIG 13: PERFORATION USING THE STABIDENT PERFORATOR AT THE SELECTED TARGET SITE

FIG 14: BLOOD MARK INDICATING THE PERFORATED SITE

FIG 15: LOCAL ANAESTHETIC AGENT ADMINISTRATION USING 27- GAUGE ULTRA-SHORT STABIDENT NEEDLE

FIG 16: ADMINISTRATION OF LOCAL ANAESTHETIC SOLUTION VIA INTRALIGAMENTARY TECHNIQUE

Result

RESULTS

Results of the present study was subjected to statistical analysis to interpret the anaesthetic efficacy of intraligamentary, intraosseous anaesthetic techniques as the primary technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis. Data entry and data base management was done in IBM. SPSS (Statistical package for social work) version 20.0 for windows).

To describe about the data descriptive statistics frequency analysis, percentage analysis were used for categorical variables and the mean & S.D were used for continuous variables. In all the above statistical tools the probability value .05 is considered as significant level.

One way ANOVA was used to find the descriptive differences between and within the three groups Chi-Square test was used to find the significance in categorical data among the three groups. **Descriptive statistics** are shown in table 13,14,15. **Categorial data** are shown tables 3, 5, 7, 9, 11.

Sixty patients were entitled to participate in the single- blinded study. The patients consisted of 31 (51.7%) women and 29 (48.3%) men (Table 2,3 & graph 1). The mean age of the patients 30 (51%). There was no significant difference between men and women in the anaesthetic success rate (P >.05)

The average mean root length of palatal root among the three groups was comparatively high 22mm (P = >.05) For distobuccal root, average mean root length value was 20.08mm (P= >.05) and for mesiobuccal root,

average mean root length value was 20.05mm (P= >.05) respectively (Table 15 and graph 7, 8, 9).

All the patients participated in the study had acute symptomatic irreversible pulpitis. Only the maxillary first and second molars with acute symptomatic irreversible pulpitis was selected for this study.

Twenty patients received buccal and palatal infiltration (Group A – Control group) with 2% lidocaine in 1:80,000 epinephrine as the anaesthetic agent. Three (15%) patients had experienced severe pain (Table 10,11 and graph 5). **During dentin cutting**, five (25%) patients had experienced pain and fifteen (75%) patients had no pain during the procedure (Table 4,5 and graph 2). **During pulp exposure**, four (20%) patients had experienced pain and sixteen patients (80%) had no pain (Table 6,7 and graph 3). **During instrumentation of the root canals,** four (20%) patients had experienced pain and sixteen patients (80%) had no pain (Table 8,9 and graph 4). The overall anaesthetic efficacy of Group A was 85% (Table 12,13 and graph 6).

Twenty patients received intraligamentary injection (Group B- Test Group) with 2% lidocaine in 1:80,000 epinephrine as the anaesthetic agent. One (5%) patient had experienced mild pain, seven (35%) patients had experienced moderate pain, two (10%) patients had experienced severe pain and ten (50%) patients had no pain (Table 10,11 and graph 5). **During dentin cutting,** eight (40%) patients had experienced pain and twelve patients (60%) had no pain (Table 4,5 and graph 2) .**During pulp exposure,** ten patients

(50%) had experienced pain and the rest ten patients(50%) had no pain (Table 6,7 and graph 3) . **During instrumentation of root canals,** three patients (15%) had experienced pain and seventeen (85%) patients had no pain (Table 8,9 and graph 4). The overall anaesthetic efficacy in Group B was 55% (Table 12,13 and graph 6).

Twenty patients received intraosseous injection (Group C- Test Group) with 2% lidocaine in 1:80,000 epinephrine as the anaesthetic agent. Six (30%) patients had mild pain, two (10%) patients had experienced moderate pain, and twelve (60%) patients had no pain (Table 10,11 and graph 5). **During dentin cutting,** two (10%) patients had experienced pain, eighteen patients (90%) had no pain (Table 4,5 and graph 2). **During pulp exposure,** eight patients (40%) had experienced pain and twelve patients (60%) had no pain (Table 6,7 and graph 3). **During instrumentation of the root canals,** all twenty (100%) patients had no pain (Table 8,9 and graph 4). The overall anaesthetic efficacy of Group C was 90% (Table 12,13 and graph 6).

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Tables and Graphs

TABLE 1: TEST GROUPS

GROUPS	NUMBER OF PATIENTS	TOOTH	ANAESTHETIC TECHNIQUE	ANAESTHETIC AGENT
A	20	Max. $1^{st}/2^{nd}$ molars	Buccal and Palatal infiltration (control group)	2% lidocaine in 1:80,000 epinephrine
B	20	Max. $1^{st}/2^{nd}$ molars	Intraligamentary Injection (test group)	2% lidocaine in 1:80,000 epinephrine
C	20	Max. $1^{st}/2^{nd}$ molars	Intraosseous injection (test group)	2% lidocaine in 1:80,000 epinephrine

TABLE 2: SEX DISTRIBUTION AMONG THE GROUPS

			Gender		Total
			F	M	
Groups	Control	Count	12	8	20
		%	60.0%	40.0%	100.0%
	Intraligamentary	Count	12	8	20
		%	60.0%	40.0%	100.0%
	Intraosseous	Count	7	13	20
		%	35.0%	65.0%	100.0%
Total		Count	31	29	60
		%	51.7%	48.3%	100.0%

TABLE 3: CHI- SQUARE TESTS- SIGNIFICANCE VALUE OF SEX DISTRIBUTION

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.337[a]	2	**.189**
Likelihood Ratio	3.372	2	.185
N of Valid Cases	60		

P value not significant >.050

TABLE 4: PAIN DURING DENTIN CUTTING AMONG THE GROUPS

			DENTINE CUTTING		Total
			NIL	PAIN	
Groups	Control	Count	15	5	20
		%	75.0%	25.0%	100.0%
	Intraligamentary	Count	12	8	20
		%	60.0%	40.0%	100.0%
	Intraosseous	Count	18	2	20
		%	90.0%	10.0%	100.0%
Total		Count	45	15	60
		%	75.0%	25.0%	100.0%

TABLE 5: CHI-SQUARE TESTS- SIGNIFICANCE VALUE OF DENTIN CUTTING

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.800[a]	2	**.091**
Likelihood Ratio	5.063	2	.080
N of Valid Cases	60		

P value not significant > .050

TABLE 6: PAIN DURING PULP EXPOSURE AMONG THE GROUPS

			PULP EXPOSURE		Total
			NIL	PAIN	
Groups	Control	Count	16	4	20
		%	80.0%	20.0%	100.0%
	Intraligamentary	Count	10	10	20
		%	50.0%	50.0%	100.0%
	Intraosseous	Count	12	8	20
		%	60.0%	40.0%	100.0%
Total		Count	38	22	60
		%	63.3%	36.7%	100.0%

TABLE 7: CHI-SQUARE TESTS – SIGNIFICANCE VALUE OF PULP EXPOSURE

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.019[a]	2	**.134**
Likelihood Ratio	4.196	2	.123
N of Valid Cases	60		

P value not significant > .050

TABLE 8: PAIN DURING CANAL INSTRUMENTATION AMONG THE GROUPS

			INSTRUMENTATION OF THE ROOT CANALS		Total
			NIL	PAIN	
Groups	Control	Count	16	4	20
		%	80.0%	20.0%	100.0%
	Intraligamentary	Count	17	3	20
		%	85.0%	15.0%	100.0%
	Intraosseous	Count	20	0	20
		%	100.0%	0.0%	100.0%
Total		Count	53	7	60
		%	88.3%	11.7%	100.0%

TABLE 9: CHI-SQUARE TESTS- SIGNIFICANCE OF INSTRUMENTATION OF CANALS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.205[a]	2	**.122**
Likelihood Ratio	6.303	2	.043
N of Valid Cases	60		

P value not significant > .050

TABLE 10: EFFICACY OF LOCAL ANAESTHETIC TECHNIQUES AMONG THE GROUPS

			ANAESTHETIC EFFICACY				Total
			Mild	Moderate	Severe	No Pain	
Groups	Control	Count	0	0	3	17	20
		%	0.0%	0.0%	15.0%	85.0%	100.0%
	Intraligamentary	Count	1	7	2	10	20
		%	5.0%	35.0%	10.0%	50.0%	100.0%
	Intraosseous	Count	6	2	0	12	20
		%	30.0%	10.0%	0.0%	60.0%	100.0%
Total		Count	7	9	5	39	60
		%	11.7%	15.0%	8.3%	65.0%	100.0%

TABLE 11: CHI-SQUARE TESTS- SIGNIFICANCE OF LOCAL ANAESTHETIC TECHNIQUES AMONG THE GROUPS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	22.324[a]	6	**.001**
Likelihood Ratio	26.088	6	.000
N of Valid Cases	60		

P value highly significant ≤ .01

	Mild	Moderate	Severe	No Pain
Control			15.0%	85.0%
Intraligamentary	5.0%	35.0%	10.0%	50.0%
Intraosseous	30.0%	10.0%		60.0%

TABLE 12: OVERALL OUTCOME OF LOCAL ANAESTHETIC EFFICACY AMONG THE GROUPS

			OUTCOME		Total
			Failure	Success	
Groups	Control	Count	3	17	20
		%	15.0%	85.0%	100.0%
	Intraligamentary	Count	9	11	20
		%	45.0%	55.0%	100.0%
	Intraosseous	Count	2	18	20
		%	10.0%	90.0%	100.0%
Total		Count	14	46	60
		%	23.3%	76.7%	100.0%

TABLE 13: ONE WAY ANOVA TESTS- SIGNIFICANCE VALUE OF ANAESTHETIC EFFICACY AMONG THE GROUPS

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.012[a]	2	.018
Likelihood Ratio	7.755	2	.021
N of Valid Cases	60		

P value highly significant ≤ .01

	Failure	Success
Control	15.0%	85.0%
Intraligamentary	45.0%	55.0%
Intraosseous	10.0%	90.0%

TABLE 14: ONE WAY ANOVA TESTS- SIGNIFICANCE VALUES OF ROOT LENGTH AMONG THE GROUPS

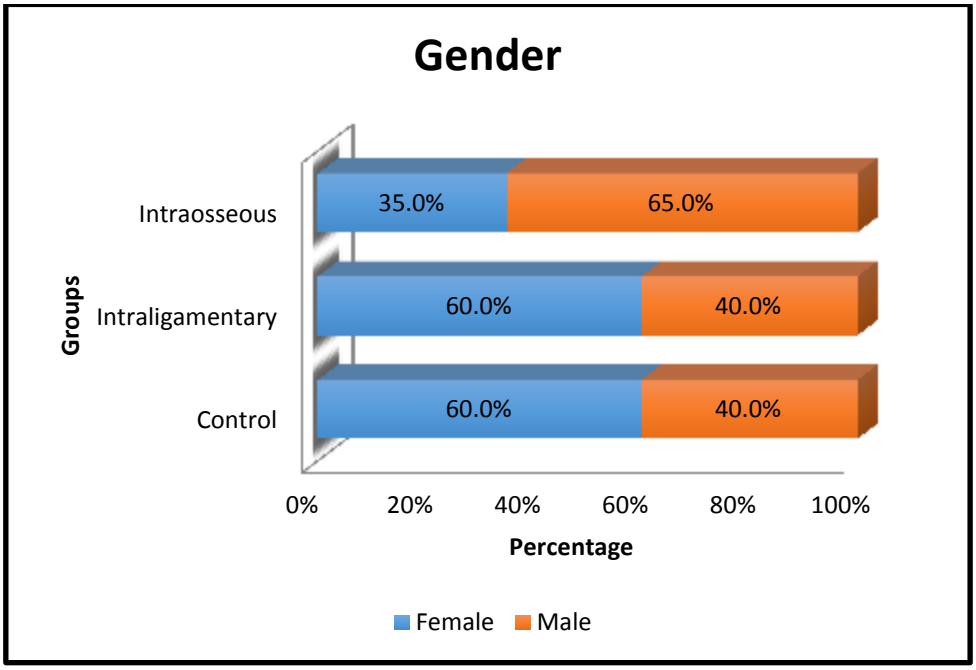
		Sum of Squares	df	Mean Square	F	Sig.
MRL	Between Groups	1.525	2	.763	2.654	**.079**
	Within Groups	16.375	57	.287		
	Total	17.900	59			
DRL	Between Groups	.308	2	.154	.481	**.621**
	Within Groups	18.275	57	.321		
	Total	18.583	59			
PRL	Between Groups	.233	2	.117	.195	**.823**
	Within Groups	34.100	57	.598		
	Total	34.333	59			

P value not significant > .050

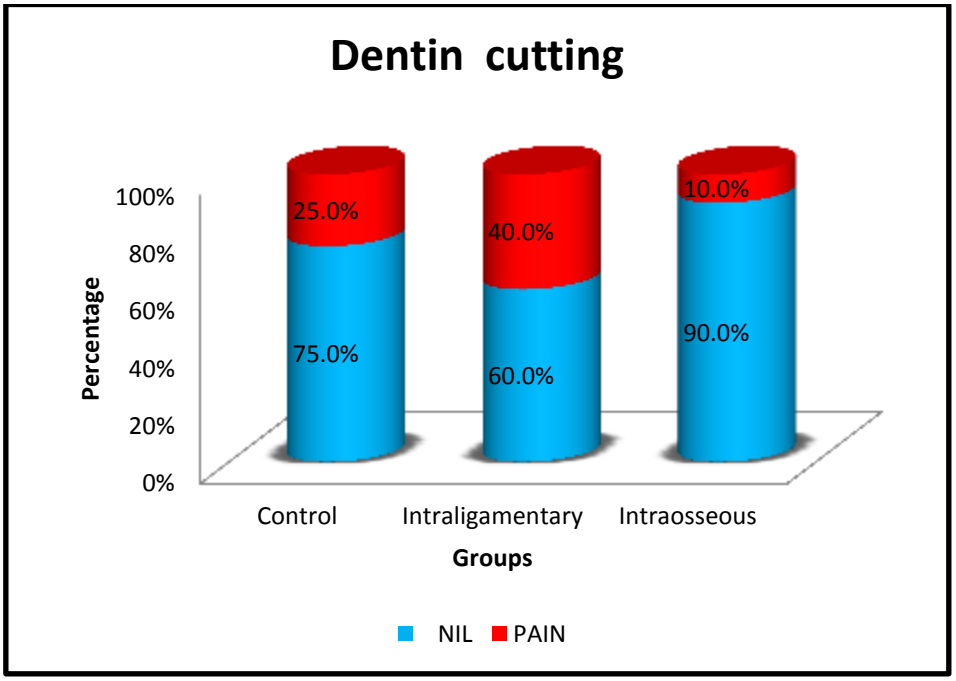
TABLE 15: DESCRIPTIVE DATA SHOWING MEAN AND STANDARD DEVIATION VALUES AMONG THE GROUPS (ROOT LENGTH)

		N	Mean	Std. Deviation
MRL	Control	20	19.80	0.41
	Intraligamentary	20	19.78	0.60
	Intraosseous	20	20.13	0.58
DRL	Control	20	20.00	0.61
	Intraligamentary	20	20.18	0.47
	Intraosseous	20	20.08	0.61
PRL	Control	20	21.60	0.82
	Intraligamentary	20	21.65	0.71
	Intraosseous	20	21.75	0.79

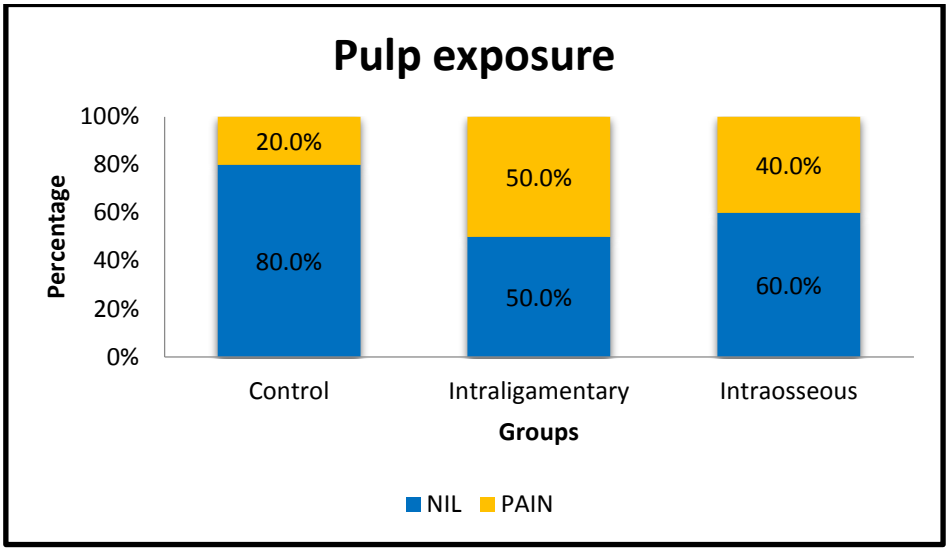
GRAPH 1: GENDER DISTRIBUTION AMONG THE GROUPS



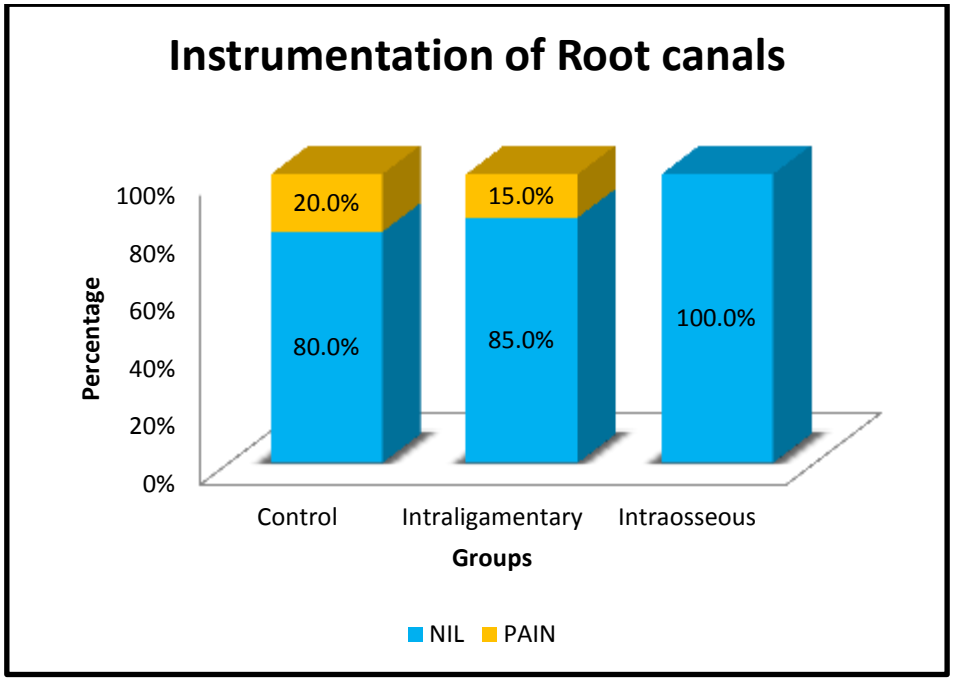
GRAPH 2: BAR GRAPH DEPICTING PAIN DURING DENTIN CUTTING AMONG THE GROUPS



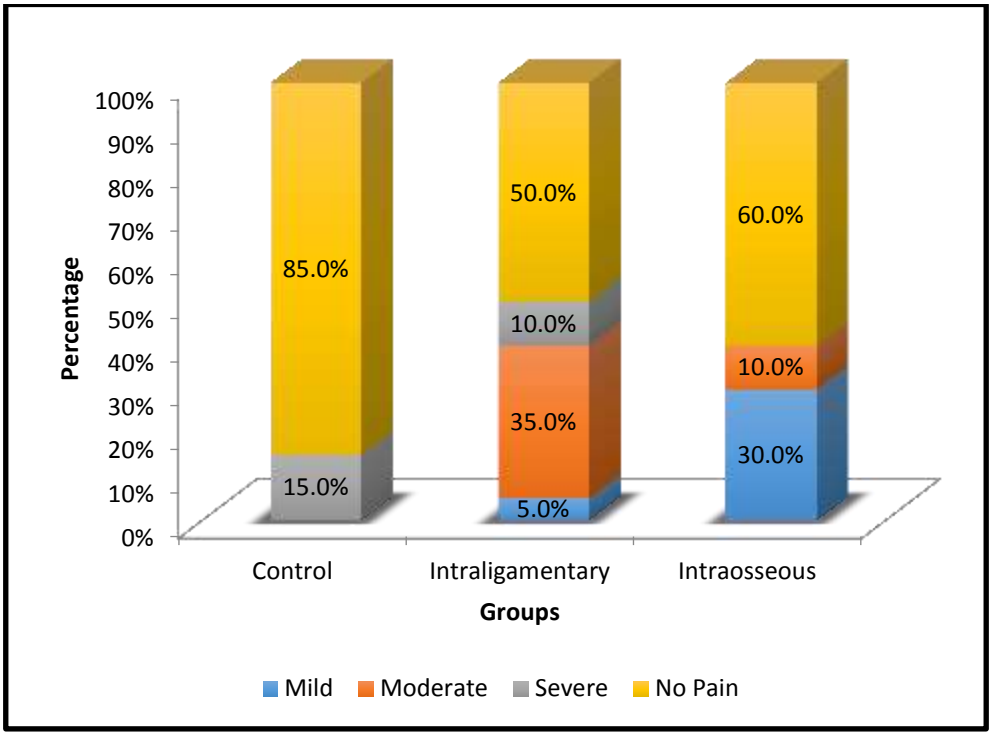
GRAPH 3: BAR GRAPH DEPICTING PAIN DURING PULP EXPOSURE AMONG THE GROUPS



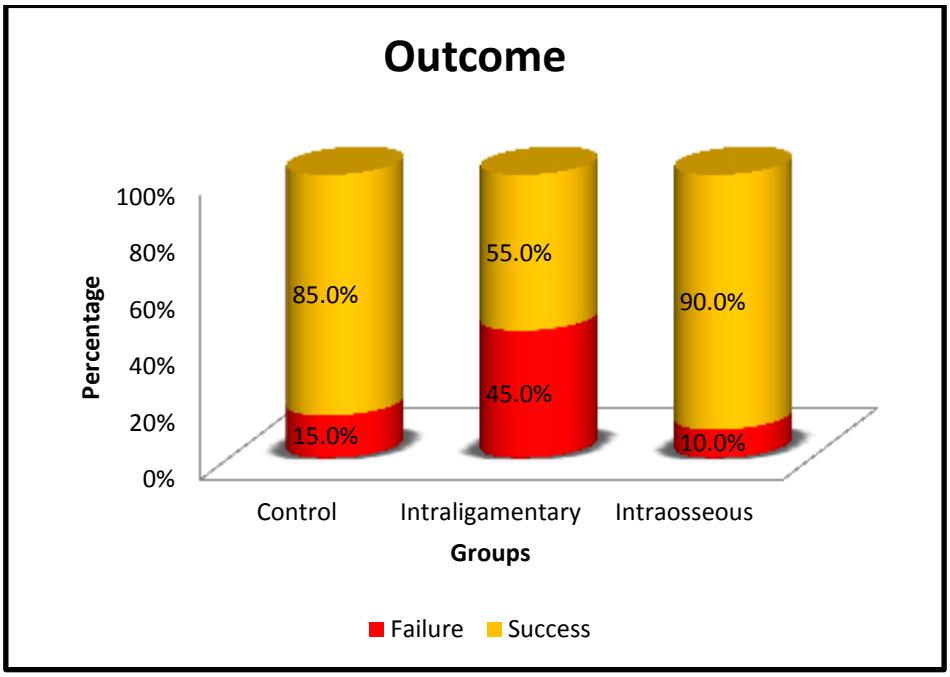
GRAPH 4: BAR GRAPH DEPICTING PAIN DURING INSTRUMENTATION OF CANALS AMONG THE GROUPS



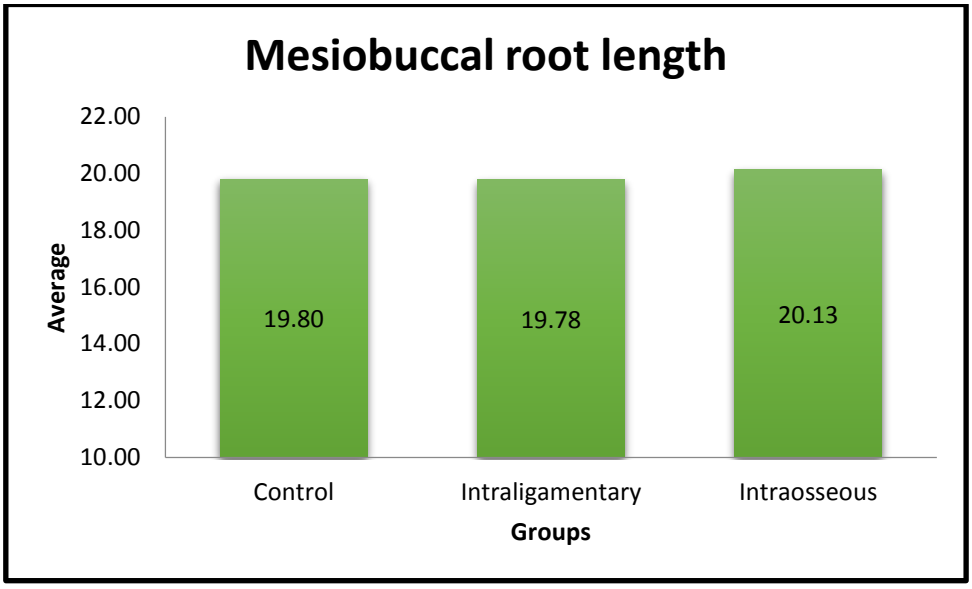
GRAPH 5: BAR GRAPH DEPICTING EFFICACY OF ANAESTHETIC TECHNIQUES AMONG THE GROUPS



GRAPH 6: OVERALL OUTCOME OF ANAESTHETIC EFFICACY AMONG THE GROUPS

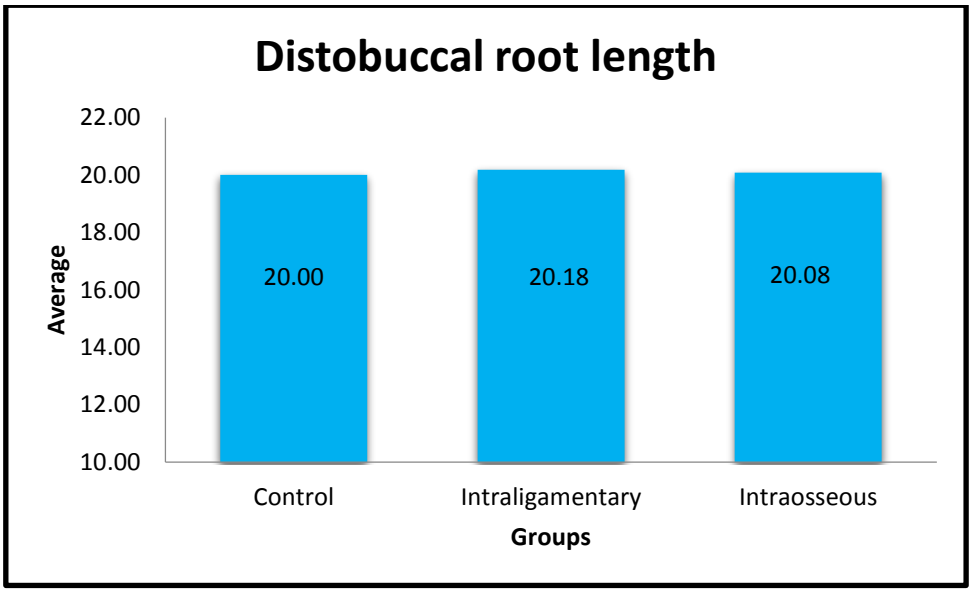


GRAPH 7: GRAPH DEPICTING THE MESIOBUCCAL ROOT LENGTH AMONG THE GROUPS



MEAN VALUE FOR MESIOBUCCAL ROOT LENGTH (MRL) = 20.05mm

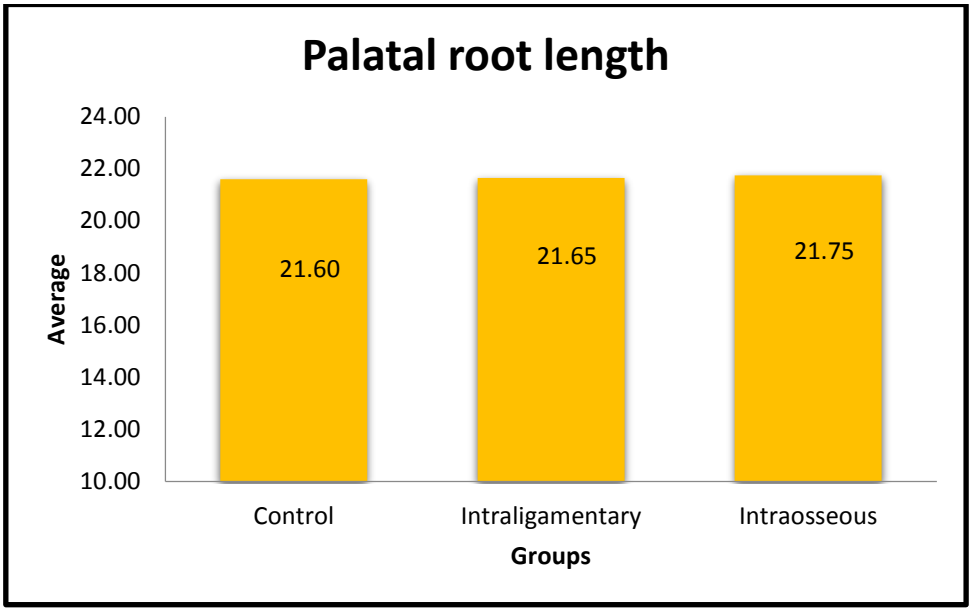
GRAPH 8: GRAPH DEPICTING THE DISTOBUCCAL ROOT LENGTH AMONG THE GROUPS



MEAN VALUE OF DISTOBUCCAL ROOT LENGTH

(DRL) = 20.08mm

GRAPH 9: GRAPH DEPICTING THE PALATAL ROOT LENGTH AMONG THE GROUPS



MEAN VALUE OF PALATAL ROOT LENGTH (PRL) = 22.0mm

Discussion

DISCUSSION

Pain has been perceived by a significant number of individuals before, during and after endodontic procedure and most of the time, pain is not mild and ranges from moderate – to severe.**(Carlos Estrela 2011)**[7]

Achieving profound pulpal anesthesia is the fundament in endodontic practice and dentistry. It benefits the patient and dentist who will be less stressed worrying about patient reactions or sudden movement during the root canal procedure.**(Kenneth M Hargreaves & Karl Keiser 2002)**[36]

Local anaesthesia is highly effective in producing anaesthesia in normal tissue, they often fail to produce the same effect to endodontic patients with inflamed pulp tissue. For IAN block, the failure rates is 15% in patients with normal tissue, whereas IAN block fails in 44%-81% in patients diagnosed with acute irreversible pulpitis **(Laura Minea 2010)**[39] The rate of success in maxillary molars with 2% lidocaine as buccal infiltration is around 70% if it's a healthy pulp tissue. It declines to 30% in cases of acute symptomatic irreversible pulpitis. Failure to achieve pulpal anaesthesia in patients with acute symptomatic irreversible pulpitis still remains a challenging process in the field of endodontics.**(Laura Minea 2010)**[39]

Acute irreversible pulpitis is a clinical condition which is characterized by severe inflammation of the pulp tissue. This condition branches from a variety of predisposing factors, which includes reversible

pulpitis, pulpal damage during operative procedures, reduced pulpal blood flow due to trauma or orthodontic movement. Furthermore, treatment of teeth with signs and symptoms of acute symptomatic irreversible pulpitis includes either root canal procedure or extraction. **(Laura Minea 2010)**[39]

In acute symptomatic irreversible pulpitis of maxillary molars, the anaesthetic success rate with various techniques and agents used are buccal infiltration 97% to 100% with 2% lidocaine in 1:100,000 epinephrine **(Alan Mikesell 2007, Grace Evans 2008, Narasimhan S 2008)**[1,17,51] . Buccal and palatal infiltration it was 95% with 2% lidocaine in 1:100,000 epinephrine **(Anna Guglielmo 2011, Vivek Aggarwal 2011)**[2,75] For posterior superior alveolar nerve block it was 64% with 2% lidocaine in 1:200,000 epinephrine **(Vivek Aggarwal 2011)**[75]

Various hypotheses have been postulated regarding the causes of local anaesthesia failure in endodontic patients with acute symptomatic irreversible pulpitis. It has been suggested that both pulpal and periradicular inflammation and infection altogether can lower the tissue pH in the affected region limiting the ability of the local anaesthetic to provide pain control. Others proposed that inflammation products were responsible for hampering the efficacy of local anaesthetic agents. Furthermore, the psychological component of the perception of pain along with dental apprehensiveness in few patients makes it a fearsome task for the endodontist to provide a " painless" experience. **(Laura Minea 2010)**[39]

The possible hypothesis for the reduction in mechanical pain thresholds in teeth with acute symptomatic irreversible pulpitis maybe due to:- sensitization of pulpal mechanoreceptors, sensitization of periapical mechanoreceptors and central sensitization **(Asma A. Khan 2007, J J Segura-Egea 2009)**[3,26]

Reasons for failure of local anaesthesia clinically is partially attributed to operator and patient related variables which can be the choice of anaesthetic solution used, anaesthetic techniques employed, individual variations in position of nerves and foramina and accessory innervations to the teeth **(Rakesh Mittal 2011)**[58] The most accepted reason can be the activation of the nociceptors by the inflammatory mediators. In an uninflamed pulpal tissue, nociceptors are normally not activated by mild temperature or pH changes. On the other hand, in an inflamed tissue two major effects on the nociceptor neurons are seen. One being, change in the functional activity of the neurons which are responsible for detecting pain and secondly inflammation altering the synthesis of proteins present in nociceptors, which causes an increase in neuropeptides such as substance P, and calcitonin gene related peptide. **(Rakesh Mittal 2011)**[58]

The success of buccal infiltration technique mainly depends on the diffusion of the local anaesthetic agent through the porous cortical plates.**(Vivek Aggarwal 2011)**[75] Whereas various authors like **Mohammed D Kanna 2012, Narasimhan S 2008, John Nusstein 1998, Vivek Aggarwal**

2011[49,51,30,75] highlighted the reduced success rate of the local anaesthetic techniques and agents in maxillary molars with acute symptomatic irreversible pulpitis. **Vivek Aggarwal et al 2011**[75] reported that none of the tested methods gave 100% ananesthetic success rates in maxillary molars with acute symptomatic irreversible pulpitis.

The aim of the study was to evaluate and compare intraligamentary intraosseous techniques as the primary anaesthetic technique along with buccal and palatal infiltrations using a common anaesthetic agent 2% lidocaine with 1:80,000 epinephrine in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Intraligamentary injection otherwise known as peridental or periodontal ligament injection technique was first introduced by Guido, Fisher,Cassamani et al in the year 1924 and gained its popularity in the early 1970's. **(Eliezer Kaufman 1884, Paul A Moore 2011)**[13,54] Dental intraligamentary anaesthesia delivers the local anaesthetic agent via the gingival sulcus to the peridental region to produce a reversible type of neural block. Intraligamentary injection can be used as both primary and as a secondary technique for achieving adequate pulpal anaesthesia in both healthy and inflamed teeth. **(M Paririokh 2014, Shaul Lin 2016, Majidah K W 2012, Song Fan 2009, Michael Childers 1996)**[45,66,41,68,46]

Michael Childers et al[46] reported a the success rate of 78%, **Song Fan et al**[68] achieved a success rate of 83.33% , **Vivek Aggarwal et al 2017**[76] reported a success rate of 83%, **M Parirokh et al 2014**[45] achieved 58% of success rate.

Quan Jing et al 2014[57] evaluated the effectiveness and safety of a computer- controlled periodontal ligament injection system to the soft tissues when used as a primary anaesthetic technique in mandibular teeth. The overall success rate was 76.5% with no irreversible adverse reactions on the periodontal soft tissues at the site of injection.

Intraosseous injection (IO) which is predominantly used as supplemental anaesthetic technique allows deposition of the anaesthetic solution directly into the cancellous bone after breeching into the cortical plate using specialized needles **(Randall Coggins 1996)**[59] . This technique can also be used as a primary anaesthetic technique to achieve profound anaesthesia in both healthy and inflamed pulp **(Kaitlyn Tom 2015)**[35]

When used as a secondary anaesthetic technique in mandibular molars **John Nusstein et al 1998**[30] achieved a success of 88% employing 2% lidocaine with 1:100,000 epinephrine, **Stephen A Parente et al 1998**[70] reported a success rate of 89% .

When this technique is used as a primary anaesthetic technique in mandibular molars with acute symptomatic irreversible pulpitis **Todd**

Remmers et al 2008[73] achieved a success of 87% using 2% lidocaine with 1:100,000 epinephrine.

Local anaesthetic solutions also plays a wide role in providing profound anaesthesia. Also in our study, the anaesthetic solution administered was 2% lidocaine with 1:80,000 epinephrine because it is one of the most widely used anaesthetic solution by general practitioners worldwide **(Ehsan Moradi Askari 2016)**[12] Three main types of anaesthetic solutions clinically used in dentistry are 2% lidocaine, bupivacaine (5% with 1:200,00 epinephrine) and 3% mepivacaine **(John Nathan 2016)**[28] Among them 2% lidocaine with concentrations 1:100,000, 1:200,000 and 1:80,000 epinephrine is the most widely used for local infiltrations. **(John Nathan 2016)**[28] Even 4% articaine with 1:100,000 epinephrine have been employed and have shown conclusive results. **(Mohammed Kanaa , Grace Evans, Ryan Shurtz, Suttapreyasri Srisurang Narasimhan Srinivasan, Michael G Sherman, Song Fan)**[49,17,64,72,51,47,68]

Bupivacaine have also been employed and is four times more potent than lidocaine.(**John Nathan, Masoud Parirokh, Sampio)**[28,43,65] 3% Mepivacaine have also been a widely used local anaesthetic agent in the absence of a vasoconstrictor. **(John Nathan, Deron Reisman, Suttapreyasri Srisurang)**[28,11,72] The type of anaesthetic solution has no significant effect on the success rate **(Hamid Reza Hosseini, Vivek Aggarwal, Parirokh M)**[18,76,53]

Also the concentration of local anesthetic solution plays an important role in the anaesthetic efficacy. **Mohammad D Kanna et al 2012[49],** administered 2ml of 2% lidocaine with 1:80,000 epinephrine and 2ml of 4% articaine with 1:100,000 epinephrine and reported a success of 58% when lidocaine was used and 66% when articaine was used as the anaesthetic agent. There is a uniformity in the anaesthetic agents used in this study. A vial containing 1.8ml of 2% lidocaine with 1:80,000 epinephrine is the anaesthetic agent for all the techniques.

In this study, maxillary first and second molars with long distobuccal and palatal roots was an inclusion criteria. Only two studies have been so far reported on long root lengths in maxillary molars with acute symptomatic irreversible pulpitis. In a investigation by **Hamid Reza Hosseini et al 2016[18]**, he highlighted that shorter palatal root was significantly better anesthetized compared with longer palatal roots when a single buccal infiltration was administered in maxillary molars diagnosed with acute symptomatic irreversible pulpitis. In the same year **Ehsan Moradi Askari et al 2016[12]** evaluated the effect of maxillary first molar root length on the success rate of buccal infiltration with 2% lidocaine in 1:80,000 epinephrine. He concluded that maxillary molars with longer root length has more chances of anaesthetic failure than compared to teeth with shorter root length.

Sixty adult volunteer patients with acute symptomatic irreversible pulpitis in maxillary first and second molars were selected in this study. They were divided into 3 groups. **Group A** received buccal and palatal infiltration with 2% lidocaine in 1:80,000 epinephrine (Control Group), **Group B** received intraligamentary injection with 2% lidocaine in 1:80,000 epinephrine (Test Group), **Group C** received intraosseous injection (Test Group) with 2% lidocaine in 1:80,000 epinephrine.

Out of sixty patients , 31 (51.7%) were women and 29 were (48.3%) men. The mean age of the patients 30 (51%) . The mean levels of pain experienced did not differ by gender. **(Watkins C A 2002)[78] J J Segura-Egea et al[26]** reported that age did not influence the mean pain levels. In his study, 39% of individuals older than 35 years felt pain whereas 60% of individuals aged 35 years and younger experienced pain . In this study the mean age was 30 so here the patients experienced pain rather than felt pain. However the endodontist must be aware that there is no concrete statistics available which relates to loss of sensitivity to stimuli which occurs with aging. **J J Segura-Egea et al[26]** in his study showed that males tolerated higher levels of pain stimulation than females. He reported that women experienced more pain during dental treatment than men. All the teeth included in this study was maxillary first and second molars with long distobuccal and palatal roots with pain rated using the Heft-Parker Visual Analog Scale (HPVAS**).** Clinically, electric pulp testing or cold test was done

for each tooth before the start of the study . All the patients underwent two sets of pulp sensibility tests one before the treatment and one after the local anaesthetic agent was administered. The contralateral side of the patient was used as the non anaesthetised control side to ensure positive reliability of the pulp testing methods **(Michael G Sherman 2008)**[47]

Absence of pain or the presence of only mild pain was considered as success of the anaesthetic technique, whereas moderate or severe pain was considered as failure of the anaesthetic technique (**Ehsan Moradi Askari 2016)**[12].

Group A, 20 patients received buccal and palatal infiltration. The anaesthetic agent used was 2% lidocaine with 1:80,000 epinephrine. While administrating the local anaesthetic solution of 1.4ml for buccal infiltration and 0.2ml for palatal infiltration. seventeen (85%) patients had no pain, three (15%) patients had experienced severe pain. During dentin cutting, five (25%) patients had experienced pain and fifteen (75%) patients had no pain. During pulp exposure, four (20%) patients had experienced pain and sixteen patients (80%) had no pain. During instrumentation of the root canals, four (20%) patients had experienced pain and sixteen patients (80%) had no pain. Additional palatal infiltration was delivered after buccal infiltration for all the patients. 10 **(**50%) patients experienced pain while administering palatal infiltration. The overall anaesthetic efficacy for Group A was 85% . Almost similar results was obtained by **Vivek Aggarwal 2011, Miksell 2008,**

Evans 2008, Mason 2009, Katz 2010, Anna 2011[75,1,17,63,71,2] which showed anaesthetic success of 70% 82% 72% 97% 83% and 95% in maxillary molars with acute symptomatic irreversible pulpitis. None of the patients experienced any incidence post operative pain, swelling, haematoma at the site of injection.

Group B (Test Group), 20 patients received intraligamentary injection. The anaesthetic agent was 2% lidocaine with 1:80,000 epinephrine . One (5%) patient had experienced mild pain, seven patients (35%) had experienced moderate pain, two patients (10%) had experienced severe pain and ten patients (50%) had no pain. During dentin cutting, eight (40%) patients had experienced pain and twelve patients (60%) had no pain. During pulp exposure, ten patients (50%) had experienced pain and the rest ten patients (50%) had no pain. During instrumentation of root canals, three patients (15%) had experienced pain and seventeen (85%) patients had no pain. The overall anaesthetic efficacy for group B was 55%.

K Peycheva et al 2014[38]**,** evaluated the efficacy of intraligamentary anaesthesia in mandibular molars with acute symptomatic irreversible pulpitis and reported a success rate of 81% - 86% when used as primary anaesthetic technique and 83%- 92% when used as secondary anaesthetic technique. **Masoud Parirokh et al 2014**[45]**,** evaluated the efficacy of supplementary buccal infiltration and intraligamentary injections to inferior alveolar nerve blocks in mandibular first molars and reported a success rate of 22% for IANB

and 58% for IANB+ILI. **Toni L Eigner et al 1990[74],** employed the intraligamentary injection technique for performing restorative management in a hemophilic patient with factor VIII deficiency. He found that this technique caused very little damage to the blood vessels.

In this study, the mechanical pressure syringe was used to deliver the anaesthetic solution containing 2% lidocaine in 1:80,000 epinephrine. **(Smith, Walton & Abbott, Stanley Malamed)[67,77,69] Joseph D'Souza et al[31]** highlighted that pressure and standard syringes did not show difference in achieving anaesthesia to the injected tooth. Out of 20 subjects who received intraligamentary injection technique, spillage of the anaesthetic solution was seen in 7 (35%) patients. This might be mainly due to improper placement of the needle bevel into the mesiobuccal and distobuccal aspect of maxillary molars. Reason for the seepage of the local anaesthetic agent imperceptably from the target site might be due to inadequate pressure applied by the operator. The minimum pressure applied by the operator should be 16 mmHg. **(John Nusstein 2005)[29].**

Potential complications of intraligamentary injection technique according to Malamed are pain during needle insertion, anaesthetic solution administration and post injection pain. In this study, none of the patients experienced pain during needle placement, or during administration of anaesthetic solution probably because the needle was placed against the tooth and not on the soft tissue as reported by **(Kaitlyn Tom 2015)[35]**

Group C (Test Group), 20 patients received intraosseous injection. The anaesthetic agent used was 2% lidocaine with 1:80,000 epinephrine. In this study the Stabident system (Fairfax Dental, Miami) was employed for the intraosseous anaesthetic delivery. This system is composed of a perforator driven by a slow-speed handpiece and a solid 27- gauge wire with a bevelled end. The anaesthetic solution is administered into the cancellous bone via the 27- gauge ultra- short injector needle which is placed in the hole created by the perforator **(Julian G 2003)[32].** The diameter of the perforator is 0.40mm **(Myer S Leonard 1995)[50]**

Six (30%) patients had experienced mild pain, two (10%) patients had experienced moderate pain, and twelve (60%) patients had no pain. During dentin cutting, two (10%) patients had experienced pain, eighteen patients (90%) had no pain. During pulp exposure, eight patients (40%) had experienced pain and twelve patients (60%) had no pain. During instrumentation of the root canals, all twenty (100%) patients had no pain. The overall anaesthetic efficacy of Group C was 90%.

Randall Coggins et al 1996[59] in his study evaluated the anaesthetic efficacy of 1.8ml of 2% lidocaine with 1:100,000 epinephrine employing intraosseous injection technique as the primary anaesthetic technique in maxillary and mandibular teeth and reported a success of 75% to 93% . **John Nusstein and Stephen A Parente (1998)[30,70]** compared the anaesthetic efficacy of intraossseous when used as a supplemental anaesthetic technique

employing 2% lidocaine with 1:100,000 epinephrine and reported a success rate of 67% and 88% .

In this study, none of the patients experienced any form of infection, soreness at the site of perforation or any purulent discharge in the gingival region after intraosseous injection. The common disadvantage faced during administering the anaesthetic solution via stabident system is difficulty to identify the perforated site with the injection needle. When the site of perforation is lost the needle is penetrated else where the needle bends because of the pressure applied resulting in the separation of needle from the soft plastic shank. Infact **Randall Coggins et al**[59] highlighted the breakage of plastic shank as a result of heat generation during intraosseous administration.

The results of the present study showed that maxillary molars with acute symptomatic irreversible pulpitis(ASIRP) which also showed longer distobuccal and palatal roots were significantly correlated to the anaesthetic failure after administration of 2% lidocaine by various anaesthetic techniques.

Studies are scarce when it comes to success of local anaesthesia in acute symptomatic irreversible pulpitis. In the past success rate of anaesthesia in maxillary molars with acute symptomatic irreversible pulpitis (ASIRP) was reported to be 90% using 2% lidocaine.

Buccal and palatal infiltration with 2% lidocaine, the anaesthetic success rate was 72%, 83,95% and 97%. **(Grace Evans, Anna G, Rick Mason, Steven Katz)**[17,2,63,71]

The first reference in literature regarding the increased root length particularly distobuccal and palatal and correspondingly lower rate of anaesthetic success was highlighted by **Ingle (2002)**[80] In 2016, **Ehsan Moradi Askari et al**[12] evaluated the effect of maxillary first molar root length on the success rate of buccal infiltration anaesthesia. He concluded maxillary molars with longer root lengths can have increased anaesthesia failure. There is a opinion regarding the root canal lengths between asian and western populations. Usually the root canal length is a concern during apical surgery. **Kim et al 2005**[37] did an invitro study to measure the root lengths of Korean population and he compared that with Caucasians. Mean values of canal length of maxillary first molar for Korean population was - 18.5mm (MB),18mm (DB) and 19mm (P) and second molars it was 18.2mm (MB), 18.2mm (DB) and 18.2mm (P) whereas for Caucasian population the maxillary first molars had a mean value of 20 mm (MB), 20.5mm (DB) and 21mm (P) for second molars it was 19.5mm (MB), 19.7mm (DB) and 20mm (P). **Hamid Reza Hoessini et al**[18] in his study revealed that the length of the palatal root significantly affects the rate of success of anaesthesia irrespective of the agent used. In this study, we found out that the palatal root (mean root length) 22mm was longer than mesiobuccal and distobuccal 20.05mm (mean

root length) 20.08mm (mean root length) root which was similar to the studies conducted by **Kim et al 2005[37].**

Generally maxillary molars with shorter root length had good anaesthetic success rate when compared with longer root length specifically palatal roots. **(Hamid Reza Hoessini 2016)[18]** The rate of success is influenced by the technique, anaesthetic agents, race, gender, and bone pattern. **(J J Segura – Egea 2009)[26]** But for each criteria there is a diverse opinion, usually it is multiple factors which influence the rate of anaesthetic success.

As far as the mesiobuccal root is concerned , as it has a very thin cortical plate overlying it , there is always a high pulpal anaesthesia most of the time. Single buccal infiltration alone results in good pulpal anaesthesia in the mesiobuccal root, whereas the palatal roots it is always lesser. The rate of success in achieving high pulpal anaesthetic in palatal canal is lesser **(Grace Evans 2008)[17]**

So in order to achieve good pulpal anaesthesia, in this study we employed the buccal and palatal infiltration for Group A. The overall anaesthetic efficacy for this group was 85%. In Group A during dentin cutting, five (25%) of the individuals had experienced pain. So there were 5 individuals who had pain while dentin cutting. In the same group four (20%) individuals had experienced pain during pulp exposure which revealed that

complete anaesthesia was not achieved in these four individuals. The same four (20%) individuals had experienced pain during instrumentation of the root canals. **Grace Evans et al**[17] highlighted that mesiobuccal root achieved good pulpal anaesthesia with buccal and palatal infiltration.

In this study the mean root length of mesiobuccal root (MRL) was 20.05mm. For the Caucasian population the mean value for mesiobuccal root (MRL) is 20mm, for Koreans the mean value was 18.5mm. The result of this study shows that the anaesthetic efficacy for bucccal and palatal infiltration was 85% which is almost similar to study conducted by **Steven Katz et al**[71] who reported a success rate of 83% . During dentin cutting the anaesthetic efficacy was 75%, pulp exposure the anaesthetic efficacy was 80% and during instrumentation of the root canals the anaesthetic efficacy was 80% . So we can assume that the overall anaesthetic efficacy was 85% when it comes pulpal anaesthesia.

Group B which was intraligamentary group , the overall anaesthetic efficacy was 55%. During dentin cutting eight (40%) patients had experienced pain and while pulp exposure ten (50%) patients had experienced pain and three (15%) patients had experienced pain during instrumentation of the canals. The overall anaesthetic efficacy of 55% in this study is similar to the one published by **Jeffrey J White et al in 1988**[24]. He reported an overall success rate of 57% in the maxillary arch. **White et al**[24] further advocated periodontal ligament injection can be considered as a primary technique to

anaesthetise tooth. The duration of anaesthesia is usually 30-60 minutes during which profound pulpal anaesthesia is achieved with 2% lidocaine in 1:100,000 epinephrine.

Infact 50% of the patients had experienced pain during pulpal manipulation which highlights that half the number had poor pulpal anaesthesia with intraligamentary injection technique. Another corresponding observation was that 7 patients had spillage during deposition of the anaesthetic solution. **John Nusstein et al[29]** highlighted that spillage of the anaesthetic solution influenced the success rate of the anaesthesia. In this 7 individuals who had spillage re- injection of the anaesthetic solution was not given.

The reasons for less anaesthetic efficacy of 55% in group B might be because:-

1. Distance of the zygomatic arch to the alveolar process.**(Ehsan Moradi Askari 2016)[12]**
2. Spillage of the anaesthetic solution**(John Nusstein 2005)[29]**
3. Size and number of opening in the cribriform plate. Another factor to be considered is number and size of the cribriform plate as highlighted by **Birn et al 1966**. He reported that greater number of opening were found in the gingival third and the size and number increased gradually from anterior to posterior. This explains why there is low

success rate in the anterior region when compared to the posterior region in both the arches.

4. Operators efficiency in properly administering the anaesthetic solution
5. Increased root length **(Ehsan Moradi Askari 2016)[12]**

Group C which was the intraosseous group, the overall anaesthetic efficacy was 90%. During dentin cutting, two (10%) patients had experienced pain. During pulp exposure eight (40%) patients had experienced pain. During instrumentation of the canals none of the patients had experienced pain.

Magnes et al[40] highlighted in his study a success rate of 98% with 2% lidocaine in 2000 cases for various dental procedures. **Replogle et al[61]** reported a success rate of 90% using intraosseous as a primary anaesthetic technique in mandibular first molars. During intraosseous injection delivery of the anaesthetic agent distal to the mesial tooth results in better anaesthetic efficacy towards the mesial tooth side as reported by **(Randall Coggins 1996)[59]** The success of this technique mainly depends on the distribution as well as the spread of the anaesthetic agent within the cancellous region. The reasons why the distal intraosseous injection site was opted might be because of the ability of the agent to spread past the tooth, and to block the nerve trunk at the site of injection **(Randall Coggins 1996)[59]** The diffusion rate of the anaesthetic solution is often from distal to mesial aspect. That's the reason why perforation is made on the distal aspect of the tooth subjected to

intraosseous anaesthesia. None of the patients had infection at the site of perforation, soreness, no reperforation, bruising and gingival inflammation.

Advantages of intraosseous injection is its inexpensive startup and inexpensive disposable costs **(Julian G 2003)[32],** bilateral mandibular anaesthesia can be achieved , use of lesser anaesthetic solution can be attained with this technique. **(David Penarrocha oltra 2012)[9]**

Todd Remmers et al 2008[73], studied the efficacy of intraosseous technique as a primary anaesthetic technique and reported anaesthetic solution leakage from the transfuser head during the injection phase. It can also be due to faulty assembling of the transfuser head onto the handpiece or because of clogging of the debris during the perforation. When obliteration of the cancellous space occurs the deposition of the anaesthetic solution around the root apices gets decreased gradually **(Julian G 2003)[32]** In this study, for Group C none of the 20 patients showed backflow of the anaesthetic solution which might be a reason for its high anaesthetic efficacy , whereas for Group B, 7 (35%) patients showed spillage of the anaesthetic solution from the target site during the procedure.

In maxillary molars, there was rapid and immediate diffusion of the anaesthetic solution via the cancellous bone **(Randall Coggins 1996)[59]**

The vascularity, bone anatomy as well as the compliance of the injection site would have affected the convection rate causing an increase in

the success rate and it can be partly through the convective transport of the anaesthetic solution from the pressure generated by the stabident system **(Paul A Shepherd 2001)**[55] Also the effective anaesthesia is due to deposition of the anaesthetic solution at close proximity of the root apices and its associated periradicular structures **(Todd Remmers 2008)**[73]

The contraindications of Intraosseous technique are gross areas of periodontal disease, mixed dentition, anatomical landmarks such as sinus, mental foramen, areas where graft has been placed, dense cortical bones, areas between the central incisors (midline region lacks cancellous bone

There is also chances of higher possibility of transient tachycardia seen while administration of local anaesthetic solution via intraosseous injection technique. The patients should be informed prior the possibilities of increased heart rate to lessen their anxiety levels. This phase lasts upto 4 mins. Transient increase in heart rate is not clinically significant in most healthy patients **(David Penarrocha -Oltra 2012, Juliane Gallatin 2003)**[9,32]

This study was undertaken to evaluate two important criterias,

1. Is there any correlation between increased root length and anaesthetic efficacy
2. Whether intraosseous and intraligamentary techniques can be efficiently considered as primary anaesthetic technique in maxillary

first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Intraligamentary injection when administered as primary anaesthetic technique achieved an overall anaesthetic efficacy of 55%. Intraosseous injection technique in this study we found out that this technique showed an overall anaesthetic efficacy of 90%. Based on this study we can suggest that, intraosseous technique can be considered as primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots with acute symptomatic irreversible pulpitis. The duration of pulpal anaesthesia was not evaluated in this technique. The size of the sample was less when compared to few studies that included large samples. The sample size was less because we included cases with long distobuccal and palatal roots in maxillary first and second molars with acute symptomatic irreversible pulpitis.

From this invivo study we conclude that, intraosseous technique with 2% lidocaine in 1:80,000 epinephrine in maxillary first and second molars with long distobuccal and palatal roots in patients acute symptomatic irreversible pulpitis had an anaesthetic efficacy of 90% when compared to intraligamentary and buccal and palatal groups (55% and 85%).

All these above reasons draws us to a conclusion that intraosseous injection technique with 2% lidocaine in 1:80,000 epinephrine can be employed as a primary mode of anaesthesia in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Summary

SUMMARY

The aim of this present study was to evaluate and compare the anaesthetic efficacy of intraligamentary, intraosseous techniques as the primary anaesthetic technique in maxillary first and second molars in patients with acute symptomatic irreversible pulpitis – (2% lignocaine with 1:80,000 epinephrine as anaesthetic agent).

In this in vivo study 60 volunteer patients participated in this single-blinded study. Healthy adults with vital maxillary first and second molars with acute symptomatic irreversible pulpitis were selected. They was divided into 3 groups.

In Group A, Buccal and palatal infiltration with 2% lidocaine in 1:80,000 epinephrine – Control group.

In Group B, Intraligamentary injection with 2% lidocaine in 1:80,000 epinephrine - Test group

In Group C, Intraosseous injection with 2% lidocaine in 1:80,000 epinephrine – Test group

Patients ability to understand and use pain scales were evaluated. Informed written consent was obtained. All patients rated their pain in Heft-Parker Visual Analog Scale (HPVAS) prior to beginning of the procedure. In

all the patients selected pulp sensibility tests was done using Electric Pulp Tester and cold test.

In **group A** (Control group) twenty patients received buccal and palatal infiltration with 2% lidocaine in 1:80,000 epinephrine, twenty patients from **group B** (Test group) received intraligamentary injection with 2% lidocaine in 1:80,000 epinephrine, twenty patients from **group C** (Test group) received intraosseous injection with 2% lidocaine in 1:80,000 epinephrine

Immediately after administration of the local anaesthesia, the patients were subjected to pulp sensibility tests to evaluate complete anaesthesia of the tooth. The teeth were subjected to dentin cutting, pulp exposure and instrumentation of the root canals. Successful pulpal anaesthesia was defined as no pain or mild pain during dentin cutting, pulp exposure and instrumentation of root canal system. The subjects were instructed to rate their pain on the Heft-Parker Visual Analog Scale (HPVAS). The values were subjected to data entry and data base management which was done in IBM. SPSS (Statistical package for social work) version 20.0 for windows). Statistical analysis was recorded with – chi- square and one way ANOVA.

All the groups showed efficient anaesthesia. Among the groups, intraosseous group showed an anaesthetic efficacy of 90% over conventional buccal and palatal infiltration groups which had an efficacy of 85% and intraligamentary group had an anaesthetic efficacy of 55%.

The results of this study, highlighted that there is a correlation between increased length of the roots and decrease in the efficacy of anaesthesia. From the results of the study we suggest that intraosseous injection technique can be considered as a primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Conclusion

CONCLUSION

Efficient anaesthesia was observed in all the groups.

- Group A buccal and palatal group, the overall anaesthetic efficacy in achieving pulpal anaesthesia in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis was 85%. The efficacy achieved during dentin cutting was 75%, for pulp exposure the efficacy was 80% and for instrumentation of root canals the efficacy was 80%.
- Group B intraligamentary group, the overall anaesthetic efficacy was 55% in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis. The efficacy achieved during dentin cutting was 60%, efficacy for pulp exposure was 50% and efficacy for instrumentation of root canals was 85%.
- Group C intraosseous group, the overall anesthetic efficacy was around 90% in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis. . The efficacy during dentin cutting was 90%, during pulp exposure the efficacy was 60% and during instrumentation of root canals the efficacy was 100%.

Among the three groups the intraosseous group showed better anaesthetic efficacy in achieving pulpal anaesthesia in maxillary molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Buccal and palatal group showed better anaesthetic efficacy than intraligamentary group but less anaesthetic efficacy than the intraosseous group in maxillary molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis.

Intraligamentary group showed the least anaesthetic efficacy in achieving pulpal anaesthesia when compared to buccal and palatal and intraosseous groups in maxillary molars with long distobuccal and palatal roots with acute symptomatic irreversible pulpitis.

Intraosseous anaesthesia in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis showed better anaesthetic efficacy when compared to intraligamentary and buccal and palatal groups.

Based on our results it can be concluded that there is a correlation between the anaesthetic efficacy and maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis in achieving pulpal anaesthesia.

This study reveals irrespective of the anaesthetic technique used there is a reduction in the anesthetic efficacy when there is a corresponding increase in the length of the root. Intraosseous technique can be considered as a

primary anaesthetic technique in maxillary first and second molars with long distobuccal and palatal in patients with acute symptomatic irreversible pulpitis.

1. Maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis showed correspondingly less anaesthetic efficacy with conventional buccal and palatal technique
2. Maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis showed least anaesthetic efficacy with intraligamentary technique when used as a primary anaesthetic technique
3. Maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis showed better anaesthetic efficacy with intraosseous technique when used as a primary anaesthetic technique.

Finally we can conclude based on our results that intraosseous injection technique can be considered as a primary mode of anaesthetic technique in maxillary first and second molars with long distobuccal and palatal roots in patients with acute symptomatic irreversible pulpitis

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Annexures

ANNEXURE –I

RAGAS DENTAL COLLEGE & HOSPITAL
(Unit of Ragas Educational Society)
Recognized by the Dental Council of India, New Delhi
Affiliated to The Tamilnadu Dr. M.G.R. Medical University, Chennai
2/102, East Coast Road, Uthandi, Chennai - 600 119. INDIA.
Tele : (044) 24530002, 24530003-06. Principal (Dir) 24530001 Fax : (044) 24530009

TO WHOMSOEVER IT MAY CONCERN

DATE: 05/02/2019
CHENNAI

From,
The Institutional Review Board,
Ragas Dental College and Hospital,
Uthandi, Chennai-600119.

The Dissertation topic titled **"TO EVALUATE AND COMPARE THE ANAESTHETIC EFFICACY OF INTRALIGAMENTARY, INTRAOSSEOUS TECHNIQUES AS THE PRIMARY ANAESTHETIC TECHNIQUE IN MAXILLARY FIRST AND SECOND MOLARS WITH LONG DISTOBUCCAL AND PALATAL ROOTS IN PATIENTS WITH ACUTE SYMPTOMATIC IRREVERSIBLE PULPITIS" – AN INVIVO STUDY** Submitted by **Dr. DARLENE ANN JOHNSON** has been approved by the Institutional Review Board of Ragas Dental College and Hospital.

DR. N S AZHAGARASAN, M.D.S
Member Secretary,
Institutional Ethical Board,
Ragas Dental College and Hospital,
Uthandi, Chennai-600119

ANNEXURE –II

URKUND

Urkund Analysis Result

Analysed Document: DARLENE IRB.pdf (D47676391)
Submitted: 2/7/2019 6:27:00 AM
Submitted By: drdarleneannjohnson@gmail.com
Significance: 3 %

Sources included in the report:

final thesis for plagiarism.pdf (D34942671)
http://endoexperience.com/documents/HotToothanesthesia.PDF
https://www.hindawi.com/journals/prm/2017/3108940/
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Instances where selected sources appear:

10

ANNEXURE –III

CONSENT FOR LOCAL ANESTHESIA

I ---------- hereby acknowledge that my doctor has explained to me that I will have to undergo root canal treatment with local anaesthesia in the particular region. She also explained to me about the expected treatment outcome and what could happen if my condition remains untreated

I also understand that anesthesia services are needed so that my doctor can perform the procedure. It has been informed that all forms of anesthesia invovles certain risks. Certain possible risks exists, that although rare, could cause pain, swelling, bleeding tendency, infection, nerve damage, and some unexpected reactions

The aim is to deposit anesthetic solution in the gum region as closely as possible to the tip of the tooth to be anesthetized and also into the adjacent bone. The local anesthetic agents used is Lignocaine which have been used for more than 15 years.

It has been explained to me that sometimes an anesthetic technique which invovles the use of local anesthetics may not succeed completely and therefore another technique or another attempt may have to be used. The expected result of local anesthesia is temporary loss of sensation in the particular area for a period of 2- 3 hours. The technique invovled is the drug is injected near the nerves providing loss of sensation to the area of operation.

I acknowledge that I have admitted all my medical conditions and the medicines taken by me for the same without hiding anything.

I certify and acknowledge that i have read this form or had it read to me, that I understand the risks, alternatives and expected results of the anesthesia service; and that i had ample time to ask questions and to consider my decision

Date and time:-

Patient's signature:-

Substitute's signature:-

Witness:-

Relationship to patient:-

ANNEXURE –IV

உறுப்பிட உணர்வு நீக்கத்திற்கான (லோக்கல் அனஸ்தீசியா) ஒப்புதல்

குறிப்பிட்ட பகுதியில் உறுப்பிட உணர்வுநீக்க மயக்கமருந்து கொடுத்து பல் வேர்க்குழி சிகிச்சையை நான் செய்துகொள்ள வேண்டியிருக்கும் என்று எனது மருத்துவர் விளக்கிக்கூறியிருப்பதை ****************** என்ற நான் இதன் வழியாக ஒப்புக்கொள்கிறேன். எதிர்பார்க்கப்படும் சிகிச்சை விளைவுகுறித்தும் மற்றும் சிகிச்சையளிக்கப்படாமல், எனது பற்களின் நிலை அப்படியே இருக்குமானால், என்ன நிகழக்கூடும் என்றும் அவர் எனக்கு விளக்கி கூறியிருக்கிறார்.

இந்த சிகிச்சை முறையை எனது மருத்துவர் மேற்கொள்வதற்கு உணர்வு நீக்க சேவைகள் அவசியப்படுகின்றன என்பதையும் நான் புரிந்துகொள்கிறேன். உணர்வு நீக்கத்திற்கான அனஸ்தீசியாவின் அனைத்து வடிவங்களிலும் சில இடர்கள் இருக்கின்றன என்றும் எனக்கு தெரிவிக்கப்பட்டிருக்கிறது. வலி, வீக்கம், காயம், தொற்று. நரம்பு சேதம் மற்றும் மாரடைப்பு, ஸ்ட்ரோக், மூளையில் பாதிப்பு மற்றும் ∴ அல்லது உயிரிழப்பு போன்றவைகளும் வெகு அரிதாக இருப்பினும் சாத்தியமுள்ள சில இடர்களுள் இவைகளும் உள்ளடங்கும்.

உணர்வு நீக்கம் செய்யப்படவேண்டிய பற்களின் உச்சிப்பகுதிக்கு முடிந்தவரை மிக நெருக்கமாக எலும்புறைக்கு மேலே மயக்கமருந்தினை சேருமாறு செய்வதே இதன் நோக்கமாகும். அதன்பிறகு, உணர்வுநீக்கம் செய்யப்படவேண்டிய பல்லுக்கு அப்பால் உள்ள இன்டர்பிராக்ஸிமல் எலும்புக்குள் உறுப்பிட உணர்வுநீக்க மருந்து செலுத்தப்படவேண்டும். இதற்கு பயன்படுத்தப்படும் உறுப்பிட உணர்வுநீக்க மருந்தானது, லிடோகெய்ன் ஆக இருக்கும்.

சிலநேரங்களில், உறுப்பிட உணர்வுநீக்க மருந்தை பயன்படுத்துகிற உணர்வுநீக்க செய்முறையானது முழுமையாக வெற்றிபெறாமல் போகலாம் என்றும், எனவே மற்றொரு முறை அச்செய்முறையை பயன்படுத்துவது அவசியமாகலாம் என்றும் எனக்கு விளக்கிக்கூறப்பட்டிருக்கிறது. உறுப்பிட உணர்வுநீக்க மருந்தின் காரணமாக எதிர்பார்க்கப்படும் விளைவு என்னவென்றால், குறிப்பிட்ட அப்பகுதியில், தற்காலிகமாக உணர்வுத்திறன் இழக்கப்படுவதே ஆகும். சிகிச்சை செயல்பாடு மேற்கொள்ளப்படுகின்ற பகுதியில் உள்ள நரம்புகளுக்கு அருகே உணர்வுநீக்க

மருந்தை ஊசிமூலம் உட்செலுத்துகின்ற இந்த செயல்முறையினால், அப்பகுதியில்
உணர்வுத்திறன் இழப்பு ஏற்படுகிறது.

மேலே குறிப்பிடப்பட்டிருக்கும் உணர்வுநீக்க (மயக்கமருந்து) சேவை செயல்முறைக்கு
இதன் வழியாக நான் ஒப்புக்கொள்கிறேன் மற்றும் ……

ஆல் இது வழங்கப்படுவதற்கு அனுமதியளிக்கிறேன். அவசியமானால்,
மருத்துவர்களால் பொருத்தமானது என்று கருதப்படும்போது, ஒரு மாற்றுவழி
அனஸ்தீசியா (உணர்வுநீக்க மருந்து) எனக்கு வழங்கப்படுவதற்கும் நான்
ஒப்புக்கொள்கிறேன்.

இப்படிவத்தை நான் வாசித்திருக்கிறேன் அல்லது எனக்கு வாசித்துக்
காட்டப்பட்டிருக்கிறது என்றும் மற்றும் இந்த உணர்வுநீக்க சிகிச்சை சேவையிலுள்ள
இடர்கள், மாற்றுவழிகள் மற்றும் எதிர்பார்க்கப்படும் விளைவுகளை நான்
புரிந்துகொண்டிருக்கிறேன் என்றும் மற்றும் கேள்விகள் கேட்பதற்கும் எனது முடிவை
பரிசீலிப்பதற்கும் போதுமான நேரம் எனக்கு தரப்பட்டது என்றும் நான்
ஒப்புக்கொள்கிறேன் மற்றும் சான்றளிக்கிறேன்.

தேதி மற்றும் நேரம்

நோயாளியின் கையொப்பம்

பதில் நபரின் கையொப்பம் சாட்சி

நோயாளிக்கு உறவுமுறை.

எழுத்தறிவு இல்லாதவரென்றால்,
எழுத்தறிவுள்ள சாட்சி ஒருவர் கண்டிப்பாக கையொப்பமிட வேண்டும் (சாத்தியமானால்,
பங்கேற்பாளரால் இந்த நபர் தேர்வுசெய்யப்படவேண்டும் மற்றும் ஆராய்ச்சி குழுவோடு
தொடர்பில்லாதவராக அவர் இருக்க வேண்டும்). எழுத்தறிவு திறனில்லாத
பங்கேற்பாளர்கள் அவர்களது பெருவிரல் ரேகையையும் பதிவுசெய்ய வேண்டும்.
ஆய்வில் பங்கேற்க சாத்தியமுள்ள நபருக்கு இந்த ஒப்புதல் படிவம் சரியாக
வாசித்துக்காட்டப்பட்டதை நான் நேரடி சாட்சியாக இருந்து கவனித்திருக்கிறேன்.
கேள்விகள் கேட்பதற்கு அவருக்கு வாய்ப்பு வழங்கப்பட்டது என்பதையும் மற்றும்
தனது ஒப்புதலை நிர்ப்பந்தமின்றி கருத்திரமாக அவர் வழங்கியிருக்கிறார் என்றும் நான்

உறுதிசெய்கிறேன்.

சாட்சியின் பெயர் (அச்சில்) …… மற்றும்

பங்கேற்பாளரின் பெருவிரல் ரேகை

சாட்சியின் கையொப்பம் ……

தேதி ……

நாள்.'.மாதம்.'.ஆண்டு

ANNEXURE –V

If illiterate

A literate witness must sign (if possible, this person should be selected by the participant and should have no connection to the research team). Participants who are illiterate should include their thumb-print as well.

I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Print name of witness_____ **AND**

Thumb print of participant

Signature of witness _____

Date _____
Day/month/year

ANNEXURE –VI

Name: Date:

Age: Gender: OP NO:

Chief complaint:

Past medical history:

List of medicines taken:

LOCAL ANESTHETIC AGENT USED:

ANESTHETIC TECHNIQUE USED:

EPT results:
Before treatment :

After LA:

Pain before starting the procedure:

Place a mark on the line below to show the amount of pain that you feel.

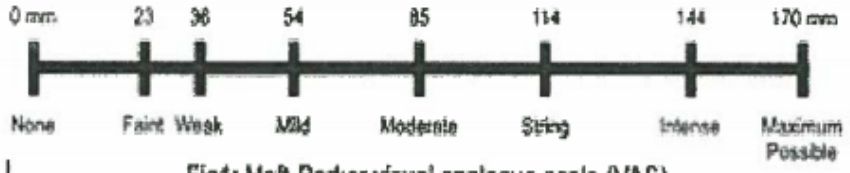

Fig1: Heft-Parker visual analogue scale (VAS)

ANNEXURE - VII

S.NO:	AGE	SEX	MAX 1ST MOLARS	MAX 2ND MOLARS	DENTIN CUTTING	PULP EXPSOURE	INSTRUMENTATION OF CANALS	MRL (MM)	DBL (MM)	PRL (MM)	SUCCESS (S)	FAILURE (F)
1	29	F	16		NIL	NIL	NIL	19	20	21	S	
2	35	M	26		NIL	PAIN	PAIN	19.5	19	21		F
3	36	F	16		PAIN	PAIN	PAIN	20	20.5	22		F
4	42	M	16		NIL	NIL	NIL	20.5	21	22	S	
5	28	FM		27	NIL	NIL	NIL	19.5	20.5	22	S	
6	32	F	26		NIL	PAIN	NIL	19	20	22	S	
7	30	F	16		NIL	NIL	NIL	20	20	20	S	
8	32	M		27	PAIN	PAIN	NIL	20.5	20.5	22.5		F
9	28	F	16		NIL	NIL	NIL	19.5	20	21	S	
10	34	F	16		NIL	NIL	NIL	19	20	22	S	
11	38	M	16		NIL	NIL	NIL	19	20	22	S	
12	29	F	26		NIL	NIL	NIL	20	20.5	22	S	
13	25	F	26		PAIN	NIL	PAIN	20.5	20.5	19.5		F
14	31	F	16		NIL	NIL	NIL	20.5	20.5	22	S	
15	28	M	16		NIL	NIL	NIL	20.5	20	22	S	
16	18	M	26		PAIN	PAIN	NIL	19	20	22		F
17	43	F		27	PAIN	PAIN	NIL	19.5	20	222		F
18	37	F	16		PAIN	PAIN	NIL	19.5	20	22.5		F
19	35	F	26		PAIN	PAIN	NIL	20.5	21	20.5		F
20	30	M	26		PAIN	PAIN	NIL	20	20	22		F
21	27	F	26		NIL	NIL	NIL	20	20	22	S	
22	29	F	16		NIL	NIL	NIL	20.5	20	20	S	
23	29	M	26		NIL	NIL	NIL	19	19	21	S	
24	42	F	16		NIL	PAIN	NIL	19.5	20.5	20.5	S	
25	24	F	26		NIL	NIL	NIL	20.5	20	22	S	
26	32	M	26		NIL	PAIN	NIL	20	20	22	S	

27	26	M	16		NIL	NIL	NIL	20.5	20.5	21.5	S	
28	18	F	16		NIL	NIL	NIL	19	19.5	22	S	
29	33	F		17	NIL	PAIN	NIL	20.5	20.5	22	S	
30	30	M	26		NIL	NIL	NIL	20	20	22	S	
31	29	M	16		NIL	PAIN	NIL	19	20	22	S	
32	23	M	26		PAIN	PAIN	NIL	20.5	20.5	22		F
33	30	M		17	NIL	NIL	NIL	20.5	20	22	S	
34	25	M	26		NIL	PAIN	NIL	20	20	22.5	S	
35	26	M	16		PAIN	PAIN	NIL	19.5	19.5	21		F
36	36	M	26		NIL	NIL	NIL	20	20	21.5	S	
37	31	M	26		NIL	PAIN	NIL	19.5	20	20	S	
38	45	M		27	NIL	NIL	NIL	19	19.5	22	S	
39	28	M		27	NIL	NIL	NIL	20	20	22	S	
40	22	F	26		NIL	NIL	NIL	19.5	20	21.5	S	
41	35	F		17	NIL	NIL	NIL	19.5	19.5	22.5	S	
42	35	F		17	NIL	NIL	NIL	20	20.5	21.5	S	
43	40	F	26		NIL	NIL	NIL	19.5	20	20	S	
44	30	F	16		PAIN	PAIN	PAIN	20	20.5	20		F
45	34	F		17	NIL	NIL	NIL	20	20.5	22	S	
46	29	F	16		NIL	NIL	NIL	19.5	20	22	S	
47	32	M	16		NIL	NIL	NIL	19.5	20	22.5	S	
48	31	M	26		PAIN	PAIN	PAIN	19.5	20	22.5		F
49	36	F	16		NIL	NIL	NIL	20.5	21	22.5	S	
50	28	F	26		NIL	NIL	NIL	20	20.5	21	S	
51	34	M	26		NIL	NIL	NIL	19.5	20.5	22	S	
52	39	M	26		PAIN	PAIN	NIL	20	20.	22.		F

									5	5		
53	20	M	16		NIL	NIL	NIL	19.5	20	22	S	
54	45	F	26		NIL	NIL	NIL	20	20	22.5	S	
55	34	F	26		PAIN	NIL	PAIN	20	20.5	22		F
56	43	M		17	NIL	NIL	NIL	19.5	20	22.5	S	
57	34	F	26		NIL	NIL	NIL	19.5	20	22	S	
58	21	M	16		NIL	NIL	NIL	20	20.5	22	S	
59	26	M	26		NIL	NIL	NIL	20	20	21.5	S	
60	32	F	26		PAIN	PAIN	PAIN	19	19.5	20.5		F